

EXHIBIT A

**IN THE UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF DELAWARE**

CORRIGENT CORPORATION,

Plaintiff,

v.

DELL TECHNOLOGIES INC. and DELL
INC.

Defendants.

C.A. No. 22-496 (RGA)

JURY TRIAL DEMANDED

CORRIGENT CORPORATION,

Plaintiff,

v.

ARISTA NETWORKS, INC.,

Defendant.

C.A. No. 22-497 (RGA)

JURY TRIAL DEMANDED

REBUTTAL DECLARATION OF DR. WILLIAM R. MICHALSON

I, William R. Michalson, declare as follows:

I. INTRODUCTION AND BACKGROUND

1. I have been retained by Defendants Dell Technologies Inc., Dell Inc. and Arista Networks, Inc. (“Defendants”) to provide assistance in the above-captioned case, including to provide my opinions rebutting proposed constructions by Plaintiff Corrigent Corporation (“Plaintiff” or “Corrigent”) regarding one or more terms in the asserted claims of U.S. Patent Nos. 6,957,369 (“the ’369 patent”) and 7,593,400 (“the ’400 patent”). I have personal knowledge of the facts and opinions set forth in this Declaration, and, if called upon to do so, I would testify competently thereto.

2. I am currently a Professor of Robotics Engineering at the Worcester Polytechnic

Institute (WPI) located in Worcester, Massachusetts. I also hold collaborative appointments as a Professor of Electrical and Computer Engineering, a Professor of Computer Science, and a Professor of Mechanical Engineering at the Worcester Polytechnic Institute. I have over 30 years of teaching and research experience, starting as an Adjunct Assistant Professor of Electrical Engineering at Worcester Polytechnic Institute in 1990.

3. Prior to joining the faculty of WPI, I worked at the Raytheon Company from 1981-1991, with a leave of absence between 1985-1988 to complete my Doctoral Degree (Ph.D.) in Electrical Engineering from the Worcester Polytechnic Institute. Prior to my leave of absence, I worked as an Engineer in the Cursive Displays Department and VLSI Design Department of the Computer and Displays Laboratory within Raytheon's Equipment Division. After receiving my Ph.D., I returned to the Equipment Division of the Raytheon Company where I was promoted to a title of Engineer, Design and Development. I was subsequently selected to sit on the engineering staff of the newly formed System Engineering Department of the Division's Computer and Displays Laboratory. In this capacity, I acted primarily as a consultant to other departments within the laboratory, and my responsibilities ranged from leading the hardware and software development of supercomputer-class computer systems to performing applied research into the exploitation of new technology. During my time at Raytheon, I worked on the development of fault-tolerant, multiple-processor computer system designs, primarily for spaceborne applications. These designs included the development of ring-based computer networks for both tightly and loosely coupled multiprocessor systems.

4. I am a named inventor on nine patents, including patents on map navigation devices, geolocation systems, and high resolution and precision location systems: U.S. Patent Nos. 10,551,923; 8,928,459; 8,284,711; 7,896,807; 7,292,189; 7,079,025; 7,158,643; 5,987,380; and

5,902,347.

5. I have authored, or coauthored, over 100 journal papers and conference publications, including papers and publications regarding positioning and navigation systems and methods. I am also the coauthor of a chapter entitled “An Approach for Implementing a Reconfigurable Optical Interconnection Network for Massively Parallel Computers” in *Optical Interconnection – Foundations and Approaches* by C. Tocci and H. J. Caulfield Eds., Artech House, 1994.

6. I have received numerous awards and recognition for my work, including becoming an Elected Senior Member of the IEEE. In addition, I was awarded the Joseph Samuel Satin Distinguished Fellowship for the 1994-1995 academic year and the Aldo Miccioli Fellowship from the Raytheon Company’s Equipment Division. I am also a member of the Institute of Electrical and Electronics Engineers, the Institute of Navigation, the Royal Institute of Navigation, the American Society of Engineering Education, the Society of Automotive Engineers, the National Marine Electronics Association, and the National Academy of Inventors.

7. I received my Bachelor of Science (B.S.) in Electrical Engineering in 1981 from Syracuse University located in Syracuse, New York, and my Master of Science (M.S.) and Ph.D. in Electrical Engineering in 1985 and 1989, respectively, from the Worcester Polytechnic Institute.

8. I joined the Computer Engineering faculty of the Electrical and Computer Engineering Department at WPI in 1990 and have taught numerous courses in computer architecture at both the undergraduate and graduate levels. In my graduate-level courses I discuss numerous types of networks used in high-performance including ring, bi-directional ring, hyper-ring, and related network topologies. As a founder of the Robotics Engineering program at WPI, I transferred from the Department of Electrical and Computer Engineering to the newly formed

Department of Robotics Engineering in 2020.

9. I am currently being compensated at an hourly rate of \$525. My compensation is not dependent on the substance of my statements in this Declaration or the outcome of the Action or the constructions ultimately adopted by the Court. My curriculum vitae is attached. *See* Attachment A.

II. RELEVANT LEGAL STANDARDS

10. I have been informed by counsel of the legal standards that apply with respect to claim construction and have used those standards in formulating my opinions. I have set forth these standards below as I understand them.

11. I have been informed that the Court will interpret certain terms of the asserted claims of the '369 and '400 patents. It is my understanding that in construing words and phrases in a claim, those words and phrases are to be given the ordinary and accustomed meaning that a person of ordinary skill in the art ("POSITA") would give them, unless a definition is set forth in the patent or its prosecution history.

12. I understand that the patent specification, the claim language itself, and the prosecution history is relevant evidence for use in discerning the correct meaning of a claim term. It is also my understanding that evidence such as expert testimony, technical treatises, dictionaries, and the like, may be consulted to determine the meaning of a claim term.

13. In forming my opinions below, I have considered the asserted patents, as well as the relevant portions of the parties' Proposed Claim Constructions and cited extrinsic evidence, including Dr. Olivier's declaration. I have also applied my personal knowledge and experience to evaluate the terms from the perspective of how they would have been understood by a POSITA in the relevant timeframe.

III. LEVEL OF SKILL IN THE ART

14. I understand that the factors that may be considered in determining the level of ordinary skill in the art include, but are not limited to, (1) the educational level of the inventor; (2) the type of problems encountered in the art; (3) prior art solutions to those problems; (4) the rapidity with which innovations are made; (5) the sophistication of the technology; and (6) the educational level of workers in the field.

15. I understand that the time of the invention for the '369 patent with the priority date of May 30, 2002, and the '400 patent with the priority date of September 4, 2001. For purposes of this declaration, I will assume these invention dates for the claims discussed herein.

16. In my opinion, a POSITA pertaining to the technology of the '369 and '400 patents at the time of the invention would be one with an undergraduate degree in electrical engineering and a background in high-performance computer networking or equivalent thereof, as well as two to four years of relevant experience in the design of high-performance computer systems, or an advanced degree with less experience.

17. My level of skill in the art was at least that of a POSITA since well before the time of invention of the '369 and '400 patents. I am qualified to provide opinions concerning what a POSITA would have known and understood at that time, and my analysis and conclusions in this Declaration are from the perspective of a POSITA as of the time of the invention of the '369 and '400 patents.

IV. REBUTTAL TO PLAINTIFF'S PROPOSED CLAIM CONSTRUCTIONS

A. '369 patent

i. *"main module" (claims 1, 2, 4, 5, 8, 9, 10, 11, 15, 16, 18, 21, 22, 23)*

18. It is my opinion that a POSITA would understand "main module" to mean "a hardware module that combines data from subsidiary modules."

19. I understand Corrigent does not dispute, and Dr. Olivier does not contest, that a “main module” is limited to a hardware-based implementation. Olivier Decl. ¶ 22. I agree. The ’369 Patent never contemplates that the “main module” can be implemented entirely as a software function.

20. The specification confirms my understanding as a POSITA that a “main module” “combines data from subsidiary modules” based on its exclusive description of the main module in this manner. For example, the patent describes a main module as “multiplexing among the subsidiary modules.” ’369 patent, 1:30-33; *see also id.* at 5:1-3 (“switch 28 aggregates upstream traffic from ports 30”), 5:13-16 (“System 20 thus provides multiplexed network access for users who are connected to subsidiary modules 24.”). A POSITA would understand the term “multiplex” in the context of a networking or communication system to mean “combine.” The specification further supports this construction through Figure 1, the only figure of the system’s architecture. Figure 1 illustrates a main module 22 that combines data from the subsidiary modules 24.

21. Corrigent’s proposed construction of plain and ordinary meaning for main module as “a module that has a connection to one or more subsidiary modules via one or more data lines or traces” is too broad. This proposed construction fails to capture the ’369 Patent’s requirement that the main module be hardware and combine data from the subsidiary modules, as I explained above. The citations that Dr. Olivier provides to support Corrigent’s proposed construction discuss the connection between the main module and subsidiary modules but leave out the relationship between the modules beyond their mere connection. Olivier Decl. ¶ 21 (citing ’369 Patent at 2:42-47, Abstract, 1:27-29, 1:61-63, 4:60-61, 7:6-7, 8:23-24).

22. Corrigent’s proposed construction is also too broad because it fails to give meaning to the word “main” in “main module.” A POSITA would understand the “main module” to be a

focal point of the system architecture. Defendants’ proposed construction does so by making clear that the main module combines (or aggregates or multiplexes) the data from the subsidiary modules. For example, the ’369 Patent explains that the main module “aggregates upstream traffic from ports 30 to an uplink trunk connecting to a high-speed network.” *See* ’369 patent at 2:44-47, 3:24-27, 4:60-63, 5:1-5. This allows the system to “provide[] multiplexed network access for users who are connected to subsidiary modules.” *Id.* at 5:13-16. As I explain above, Figure 1 also illustrates that the main module combines the data from the subsidiary modules and sends it to the network. *Id.* at Fig. 1; 4:54-5:5.

23. I have not addressed Dr. Olivier’s opinions concerning disputing the need for a “switch for multiplexing among subsidiary modules” as a component for the main module (see Olivier Decl. ¶ 22). I believe the need to present an opinion on this issue is not presently necessary based on the construction provided by Defendants in their responsive brief. To the extent this is not true, I reserve the right to provide a responsive opinion and/or to supplement my declaration.

ii. “subsidiary module” (claims 1–3, 5, 8–12, 15–17, 21–24)

24. It is my opinion that a POSITA would understand “subsidiary module” to mean “a hardware module under the control of the main module.”

25. As with “main module,” I understand Corrigent does not dispute, and Dr. Olivier does not contest, that a “subsidiary module” is limited to a hardware-based implementation. See Olivier Decl. ¶¶ 23-24. I agree. The ’369 Patent similarly never contemplates that the “subsidiary module” is solely implemented in software.

26. The claim language and specification support my opinion that a POSITA would understand a “subsidiary module” to be “under the control of the main module.” For example, claims 15 and 21 require the “subsidiary module” to be instructed by the system control processor, which is part of the main module, to perform all the required steps of the claimed method. The

specification also supports this interpretation of “subsidiary module,” explaining that the “master module” “instructs the subsidiary module.” ’369 Patent at 2:5-17. As I explain below in IV.A.v., the “system control processor” is itself part of the main module. *See also id.* at 5:41-45 (“The test procedure is supervised by an embedded system control processor 42 in main module 22 . . .”).

27. While Claim 1 does not explicitly claim a system processor, it claims a main module and highlights steps of the testing process that are to be directed and controlled. These steps are directed by the main module, which controls the subsidiary modules. Claim 1 claims “first and second subsidiary modules connected to the main module.” It further discloses “selecting a first idle line . . . to serve as an aid line;” “instructing the first subsidiary to loop back traffic”, “configuring the switch to link the first and second ports;” “transmitting test traffic over the second idle line from the second subsidiary module to the main module”. These steps are completed via a subsidiary module that is controlled and “instructed” by the main module, in the first instance, via the aid line. The main module is further able to direct the flow of traffic from the subsidiary module to itself. The specification discloses that “[i]n order to test the idle lines and the circuitry associated with them, the master module selects one of the idle lines to serve as an aid line. It instructs the subsidiary module to which the aid line is connected to loop back all traffic that reaches it via the aid trace.” ’369 Patent, 2:5-9. “The master module then selects another one of the idle lines to be tested, and configures the switch so that it connects the line selected for testing to the aid line. The master module instructs the subsidiary module to which the tested line is connected to transmit test traffic over the tested line.” A POSITA working to understand the scope of the claimed invention and how the “selecting,” “instructing,” “configuring” would function in the context of the components of the claimed electronic system would conclude that the main module is the master module that controls the subsidiary module to implement these steps.

28. A POSITA would also understand other portions of the '369 Patent to support Defendants' construction. The specification describes the main module as controlling the subsidiary module via "a separate control channel." '369 Patent at 5:41-45. The patent also describes one of its main benefits as not requiring the subsidiary module to do any processing but rather operating under the control of the main module. *Id.* at 2:6-13 ("...the master module selects one of the idle lines to serve as an aid line. It instructs the subsidiary module to which the aid line is connected to loop back all traffic that reaches it via the aid trace. This loopback function does not require that the subsidiary module decode or process the traffic—only that it send it back bit by bit to over the aid line to the master module. The master module then selects another one of the idle lines to be tested . . .").

29. The '369 patent also exclusively describes the subsidiary module according to its relationship with the main module. *Id.* at 1:25-36. Specifically, the patent discusses how the subsidiary module is connected to the main module through the backplane. *Id.* Figure 1's configuration demonstrates how the subsidiary modules rely on the main module—with the subsidiary modules 24 being attached to the main module and going through the backplane and main module to reach the network, or each other. *Id.* at 4:54-5:9.

30. Corrigent's proposed construction for "subsidiary module" is too broad for the same reasons its construction of "main module" is too broad. It eliminates "subsidiary" from "subsidiary module." Under Corrigent's construction, a subsidiary module would simply be any module connected to a main module and a main module would also be any module attached to subsidiary modules. There would therefore be no real distinction between the "main module" and the "subsidiary module," even though both the claim language and specification make it clear that this distinction exists. A POSITA would understand the "subsidiary" module to be under the

control of the “main” module.

iii. “backplane” (claims 5, 10, 15, 21)

31. It is my opinion that a POSITA would understand “backplane” to refer to a “printed circuit board.”

32. I understand that Corrigent and Dr. Olivier argue that the FutureBus+ is an example of a backplane that is not a printed circuit board. That is a demonstrably incorrect statement from a technical perspective. The FutureBus+ required a printed circuit board. *See Standard for FutureBus+ - Physical Layer and Profile Specification*, IEEE Std 896.2-1991, 1991 at 120–25 (Attach. B). In fact, the IEEE Standard for FutureBus+ defines a backplane as an “[e]lectronic circuit board and connectors used to interconnect modules together electrically.” *See Standard for FutureBus+ - Physical Layer and Profile Specification*, IEEE Std 896.2-1991 (1992) at 20 (App. B).

33. In his declaration, Dr. Olivier cites to U.S. Patent No. 5,420,985 (“Cantrell”), which states that “FutureBus+ is an IEEE specification for high-performance backplane-based computing,” and “a comprehensive architectural specification . . . for which there are no preconceived restrictions in terms of architecture, microprocessor, and software implementations” to support his position that the FutureBus+ does not use a printed circuit board. Olivier Decl. ¶ 26. As just mentioned, the IEEE standard to which Cantrell refers is IEEE 896.2, which states that FutureBus+ requires a backplane and defines backplane in a manner consistent with Defendants’ proposed construction.

34. In the passage that Dr. Olivier cites, Cantrell is not referring to the backplane, but to the computer architecture of a system constructed using FutureBus+ to interconnect modules. Specifically, by saying there are no “preconceived restrictions” Cantrell is referring to restrictions on the computer architecture (e.g., single processor, multiple processor, tightly-coupled

multiprocessor, loosely-coupled multiprocessor, etc.), the type of microprocessor (i.e., AMD, Intel, Motorola, etc.), or the software (e.g., Linux, Windows, etc.). In contrast to Dr. Olivier's technically incorrect opinion, Cantrell clearly communicated the use of the IEEE FutureBus+ standard, and that standard clearly required a printed circuit board. Olivier Decl., Ex. 2B at 1:42-48. In fact, one implementation of FutureBus+ utilized 14-layer printed circuit boards as the backplane. See Michael N. Perugini, *Passive Backpanels, Assembled Component Content Examination of Platform Specific Bus Architectures*, Integrated System Technologies at 3 (App. C).

35. Dr. Olivier states “[i]n the FutureBus+ implementation, modules could be interconnected using a backplane by using this backplane in either a loosely coupled or tightly coupled paradigm.” Olivier Decl. ¶ 26. This is misleading. In my opinion, a person of skill would have understood that, when Cantrell speaks of a loosely coupled paradigm, it is referring to the architecture of the computer system being implemented—not the backplane. Specifically, in a loosely coupled multiprocessor architecture, the memory used by the microprocessors is distributed amongst the microprocessors. In a tightly coupled multiprocessor architecture, the memory in the system is shared amongst the other processors in the system. These terms are not relevant to the backplane implementation.

36. Based on my experience, it is also my opinion that a POSITA would understand “backplane” to “provide communications pathways between modules.” Dr. Olivier also offered the same opinion. Olivier Decl. ¶ 27 (“a backplane can represent any hardware that facilitates interconnections so that communications can be made between components or modules . . .”). The intrinsic evidence also supports this conclusion. The '369 Patent's specification incorporates another patent by reference: U.S. Patent No. 5,841,788 (“Ke”) (see '369 Patent at 1:47-49), which

further supports this conclusion. I understand patents incorporated by reference are part of the intrinsic evidence and may be relied on where necessary to illuminate the scope of a claim term. Ke describes backplanes as having “slot connectors into which the edge connectors of circuit boards are inserted and have interconnects for providing communication pathways between boards.” Ke at 1:23-26.

iv. “idle line” (claims 1, 4, 7) / “idle trace” (claims 15, 18, 20)

37. It is my opinion that a POSITA would understand “idle line” and “idle trace” to mean “a [trace/line] that is determined to be inactive” because the ordinary meaning of the term “idle” is “unemployed or unoccupied” (Ex. D2 at 768) or “not working or active.” Ex. D1 at 951. I disagree with Dr. Olivier’s assertion that a POSITA would understand that an “idle” line is “a line/trace that have [sic] spare capacity for testing”. Olivier Decl. ¶ 29. This is not the ordinary meaning of idle.

38. I disagree with Dr. Olivier’s opinion that this purpose means that “idle lines” are lines that are lines that can be tested without disrupting traffic. Olivier Decl. ¶ 29. The ’369 patent is called “Hidden Failure Detection” and explicitly states it is directed at detecting hidden failures. ’369 patent, [54], 1:11–24, 2:26–29, 4:43–50, 5:37–41, 5:55–58. Specifically, the ’369 patent is clear that the purpose of the invention is to “enable[] an electronic system to test its idle lines and components and detect hidden failures without intruding on normal traffic carried by the system’s active lines.” ’369 patent at 2:26–29. If a line is carrying normal traffic, the fault would not be hidden. *Id.* Therefore, it is my opinion that a POSITA would understand that the ’369 patent is directed at detecting faults in lines that are were determined to be inactive. ’369 patent at Abstract, [54], 1: 11–24.

39. In order to be able to test idle lines, it is my opinion that a POSITA would know that a determination mechanism was required in order to determine if a line is idle or not. Contrary

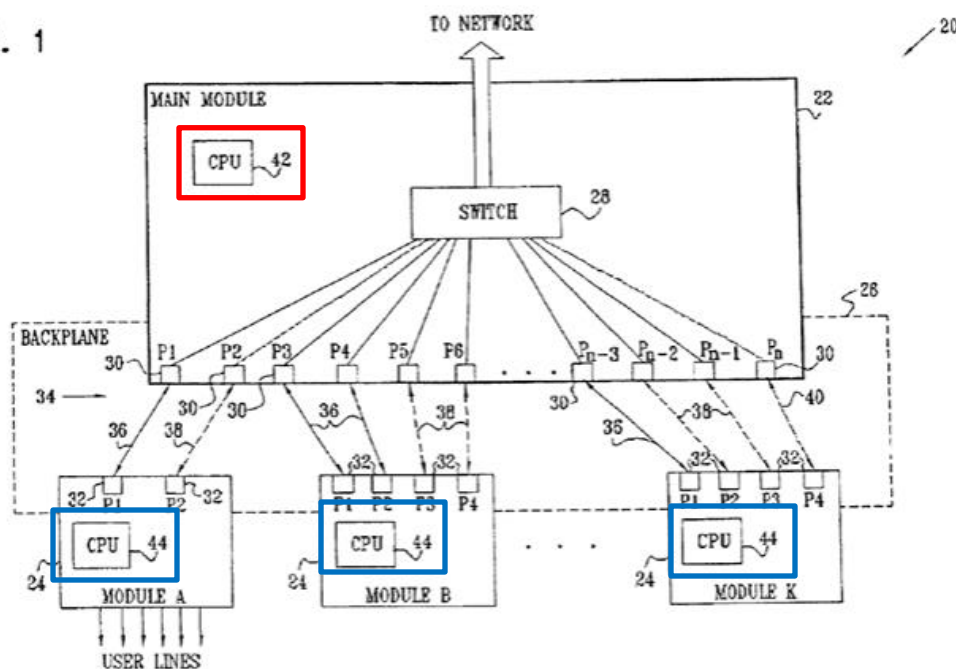
to Dr. Olivier, the patent describes such a mechanism when it states “Processor 42 maintains a database of management information regarding subsidiary modules 24, including a list of which traces are active, and which are idle. When a trace changes state, or when a module is inserted in or removed from the backplane 26, processor 42 updates the database accordingly and uses the updated database in carrying out the next cycle of testing.” ’369 patent at 6:47–53; Olivier Decl. ¶ 29. Without first determining if a line is idle, it would be impossible to know if the purpose of the patent was achieved – to test idle lines. Dr. Olivier’s interpretation would eliminate the purpose of the patent and claim testing of all lines.

40. Therefore, it is my opinion that a POSITA would understand “idle line” and “idle trace” to mean “a [trace/line] that is determined to be inactive.”

v. “system control processor” (claims. 15, 16, 18, 21, 23, 24)

41. It is my opinion that a POSITA would understand that a system control processor is “a processor residing in the main module.” Based on the disclosures in the ’369 patent, a system control processor must reside on the main module. ’369 patent at 5:41–45, Fig. 1. The ’369 patent also makes clear that the system control processor is different than the processors on the subsidiary modules when it states “[t]he test procedure is supervised by an embedded **system control processor 42** in the main module **22**, in communication with **subsidiary processors 44** on subsidiary modules **24** via a separate control channel (not shown) on a backplane **26**.” *Id.* at 5:41–45. ’369 patent at 5:41–45, Fig. 1. This is demonstrated in Fig. 1 below.

FIG. 1



42. Further, as the system control processor is the component that is directing and controlling the claimed apparatus, a POSITA would understand that the system control processor is on the main module and not the subsidiary modules. '369 patent cls. 15, 21. Specifically, the system control processor must configure the switch on the main module. *Id.* A POSITA would know that only the processor on the device that is being configured would be able to accomplish this. Further, the system control processor must select both subsidiary modules and traces that are connected to the main module for testing. *Id.* A POSITA would know that these steps must be accomplished by a processor on the main module because both subsidiary modules must be selected by the processor, but the main module does not. Further, it would only make sense for a processor on the main module to select the traces, as the main module is connected to both subsidiary modules. It would make no sense to have a subsidiary module select traces between

two different modules. Therefore, it is my opinion that a system control processor is “a processor residing in the main module.”

vi. Order of steps (claims 1, 8, 15, 21)

43. It is my opinion that a POSITA would read the '369 patent as requiring an order of steps in claims 1, 8, 15, 21. The steps of claim 1 are reproduced below:

- [1A] selecting a first idle line among idle lines connecting the first subsidiary module to a first port of the switch on the main module to serve as an aid line;
- [1B] instructing the first subsidiary module to loop back traffic reaching the first subsidiary module via the aid line;
- [1C] selecting for testing a second idle line among the idle lines connecting the second subsidiary module to a second port of the switch on the main module;
- [1D] configuring the switch to link the first and second ports;
- [1E] transmitting test traffic over the second idle line from the second subsidiary module to the main module, wherein the test traffic is conveyed via the switch to the aid line connecting to the first subsidiary module; and
- [1F] reporting that a failure has occurred if the test traffic does not return to the second subsidiary module within a predetermined period of time.

44. A POSITA would view these steps as the instructing step occurring after the completion of the first selection because the instructing step refers to the result of the selecting step. Specifically, the instructing step [1B] requires instructing the first subsidiary module to loop back all traffic that comes on the aid line. '369 patent, cl. 1. This would be impossible to do unless a line was selected to act as the aid line first [1A].

45. A POSITA would view these steps as requiring the configuring step to be performed after the completion of both selections because the configuring step refers to the results of the selection steps. Specifically, the configuring step refers to linking the ports which connect the aid and test line to the main module. *Id.* at cl. 1. A POSITA would know that the switch cannot link the ports of the aid line and test line without knowing which lines were selected as the aid line

or the test line.

46. A POSITA would view these steps as requiring the transmitting step to be performed after the completion of both selections because the transmitting step refers to the results of the selection steps. Specifically, the transmitting step requires sending a packet through the aid and test lines via the switch. *Id.* A POSITA would know that this cannot be done without first selecting which line is the aid line and which is the test line. *Id.*

47. The same order appears in the other independent claims and equally applies to these claims for the reasons presented above. Below is a chart which demonstrates the similar language and reliance on the previous steps.

Claim 1	Claim 8	Claim 15	Claim 21
selecting a first idle line among idle lines connecting the first subsidiary module to a first port of the switch on the main module to serve as an aid line;	selecting first and second subsidiary modules of different types for testing among the multiple subsidiary modules, the first and second subsidiary modules being configured to transmit and receive the data in different, respective first and second formats;	to select a first idle trace among idle traces connecting the first subsidiary module to a first port of the switch on the main module to serve as an aid trace	select first and second subsidiary modules of different types for testing among the multiple subsidiary modules,
instructing the first subsidiary module to loop back traffic reaching the first subsidiary module via the aid line;	instructing the first subsidiary module to loop back traffic reaching the first subsidiary module from the main module;	to instruct the first subsidiary module to loop back traffic reaching the first subsidiary module via the aid trace,	which is further operative to test the modules by causing the first subsidiary module to loop back traffic reaching the first subsidiary module from the main module,
selecting for testing a second idle line among the idle lines connecting the second subsidiary		select for testing a second idle trace among the idle traces connecting the second subsidiary module to	

Claim 1	Claim 8	Claim 15	Claim 21
module to a second port of the switch on the main module;		a second port of the switch on the main module	
configuring the switch to link the first and second ports ;	configuring the main module to connect the first and second subsidiary modules , so that the traffic transmitted by the second subsidiary module is conveyed to the first subsidiary module via the main module and is then looped back via the main module to the second subsidiary module ; and	configure the switch to link the first and second ports	configuring the main module to connect the first and second subsidiary modules
transmitting test traffic over the second idle line from the second subsidiary module to the main module, wherein the test traffic is conveyed via the switch to the aid line connecting to the first subsidiary module; and	testing the system by causing the second subsidiary module to transmit test traffic in the second format to the main module,	cause test traffic to be transmitted over the second idle trace from the second subsidiary module to the main module, wherein the test traffic is conveyed via the switch to the aid trace connecting to the first subsidiary module	causing the second subsidiary module to transmit test traffic in the second format to the main module,
reporting that a failure has occurred if the test traffic does not return to the second subsidiary module within a predetermined period of time.	and assessing whether the test traffic is returned intact from the first module .	report that a failure has occurred if the test traffic does not return to the second subsidiary module within a predetermined period of time.	and assessing whether the test traffic is returned intact from the first module .

48. Dr. Olivier's opinion misunderstands the order in which the steps are required to be performed. It is true that 1[C] can be performed before [1A], however, the defendants' construction allows for this, as the Defendants' construction only requires that [1A] occur before

[1B]. Further, Defendants’ construction also allows [1C] to occur before [1B], as long as [1A] and [1C] occur before [1D]. Further, Dr. Olivier admits that [1E] must occur after [1D]. Dr. Olivier ¶ 33.

49. It is my opinion that the steps cannot be performed simultaneously for the same reasons above – the steps refer to the results of previous steps. Dr. Olivier ¶ 34. It would be impossible for instruction and configuration to occur at the same time as a selection because those steps require the lines to be chosen first. There is also nothing in the specification which alludes to whether the steps can be performed simultaneously. ’369 patent, Fig. 2.

50. It is my opinion that the order of steps are also applicable to the apparatus claims. Dr. Olivier ¶ 35. Claims 15 and 21, though an apparatus, require the same steps as the method claims. ’369 patent, cls. 15, 21. Therefore, it is my opinion that the claims require the instructing step to be performed after the completion of the first selection; the configuring step must be performed after the completion of both selections; and the transmitting step to be performed after both selections.

B. ’400 patent

- i. “said FDB” as the term appears in the claim limitation for claim 1, “if said MAC destination address does not appear in said FDB, flooding said data packet”/ as the term appears in the claim 11 “when said MAC destination address does not appear in said FDB, to flood said data packet” (claims 1, 11)*

51. In my opinion, a POSA reading claims 1 and 11 would not be able to ascertain the meaning of “said FDB” as the term appears in the claim limitation “if said MAC destination address does not appear in said FDB, flooding said data packet” for claim 1, and as the term appears in the claim limitation “when said MAC destination address does not appear in said FDB, to flood said data packet” for claim 11 with reasonable certainty. The claims recite multiple “FDBs” and

later ambiguously refer to “said FDB” without clarifying which one of the previously cited FDBs is being referenced. For example, claim 1 recites:

configuring a network node having a plurality of ports, and *at least first and second line cards* with respective first and second ports, to operate as a distributed media access control (MAC) bridge in a Layer 2 data network;

configuring a link aggregation (LAG) group of parallel physical links between two endpoints in said Layer 2 data network joined together into a single logical link, said LAG group having a plurality of LAG ports and *a plurality of conjoined member line cards*;

providing for *each of said member line cards a respective forwarding database (FDB)* to hold records associating MAC addresses with ports of said plurality of ports of said network node;

receiving a data packet on an ingress port of said network node from a MAC source address, said data packet specifying a MAC destination address on said Layer 2 data network;

conveying, by transmitting said data packet to said MAC destination address via said first port, said received data packet in said network node to at least said first line card for transmission to said MAC destination address;

if said MAC destination address does not appear in *said FDB*, flooding said data packet via one and only one LAG port of said plurality of LAG ports;

checking said MAC source address of the data packet against records in *said FDB of said first line card*

52. Based on my review of the claims, there are two sets of line cards that are claimed: (1) “*first and second line cards*” and (2) “*a plurality of conjoined member line cards*.” The claim then requires that “each of said *member line cards*” (not the *first and second line cards*) has “a respective forwarding database (FDB).” Next, the claims recite checking “said FDB,” without specifying which one of the FDB of the plurality of member line cards. A person of skill would not have understood to which one of the multiple FDBs was being referenced in the claim.

53. Additionally, claim 1 recites “said FDB *of said first line card*,” *but the claim never recited an FDB on the first line card.* ’400 patent, cl. 1. If the claimed first and second line cards

also have FDBs even though they are not recited in the claims, these provide additional potential FDBs to which the earlier-claimed “said FDB” could refer to in addition to the recited FDBs that reside on the plurality of member line cards. A person of skill could not ascertain with reasonable certainty which of the claimed (or unclaimed) FDBs is the “said FDB.”

54. In my opinion, claim 11 is indefinite for the same reasons. Unlike claim 1, claim 11 recites that the “first and second line cards” are a part of the plurality of member line cards. Claim 11, however, still ambiguously recites “said FDB” without clarifying to whether it is referring to the FDB on the first line card or the FDB on the second line card. *See* ’400 patent, cl. 11 (“when said MAC destination address does not appear in *said FDB*, to flood said data packet via one and only one of said LAG ports.”).

55. Therefore, because “said FDB” in both claim 1 and 11 render the claims indefinite, and all the other dependent claims depend from either claim 1 or 11, in my opinion, all of the claims of the ’400 patent are therefore indefinite.

ii. “virtual media access control (MAC) bridge” (claims 8, 11, 18)

56. The term “virtual MAC bridge” does not have a well-understood or common meaning in computer networking. A person of skill would understand the meaning of a “MAC bridge” and typically when the word “virtual” is prepended to a component, the inference is that the component itself is a virtual component or an emulation of the component. Thus, when first reading the term virtual MAC bridge, one would assume that it was an emulation of a MAC bridge and not a physical MAC bridge. This appears to be what Dr. Olivier opines when he states that the virtualization of MAC bridges would have been known and quoting from RFC 4026 that a VPLS “emulates a learning bridge.” Olivier Decl. ¶ 48. However, in reviewing that section of RFC 4026, it is clear that it is not talking about a “virtual MAC bridge,” but the whole phrase reads “the provider network emulates a learning bridge.” RFC 4026 § 3.3. In fact, “virtual MAC bridge”

is not found anywhere in the RFC 4026.

57. Additionally, in further reviewing Dr. Olivier’s opinions, Dr. Olivier next opines that the meaning of virtual MAC bridge is based on its functionality—that it serves a virtual private network (VPN) instance. Olivier Decl. ¶¶ 46–47. But reciting the claim language where the virtual MAC bridge is “configured to” perform a certain function only tells us what a virtual MAC bridge is capable of doing, it still does not explain what a virtual MAC bridge is or how it differs from a non-virtual MAC bridge or a distributed MAC bridge.

58. In reviewing the claim language, it provides no clarity. To the contrary, the claims separately claim a “***distributed*** [MAC] bridge” (claim 1) and “***virtual*** [MAC] bridge” (claim 11). And then confusingly, claim 8—which depends from claim 1 that recites “distributed MAC bridge”—further limits the claim by reciting “the network node is configured to operate as ***multiple virtual MAC bridges*** in a Layer 2 virtual private network (VPN), wherein ***each virtual MAC bridge*** is configured to serve a respective VPN instance, and wherein the records associating the MAC addresses with the respective ports are maintained independently for each of the VPN instances.” ’400 patent, cl. 8. Again, besides reciting the fact that there are multiple virtual MAC bridges and the fact that they can be configured to serve a respective VPN instance, it provides no guidance on what a virtual MAC bridge is. Furthermore, while a POSITA would understand that the virtualization of a LAN refers to using software to “virtually” separate LAN traffic into different groups, a POSITA would also know that virtual LANs may use real, physical MAC bridges.

59. Based on my review of the specification, it likewise provides no guidance on the scope of the term, only reciting the nodes may operate as a “virtual MAC bridge,” without explaining what it means. *See, e.g.*, ’400 patent at 3:3–7, 4:54–60, 5:11–18. Additionally, based

on my review of the file history, there is nothing that clarifies the scope of “virtual MAC bridge.”

60. Thus, it is my opinion that a person of ordinary skill in the art could not ascertain with reasonable certainty the meaning of “virtual MAC bridge” and it is indefinite.

iii. Order of steps (claims 1, 11)

61. Based on my review, it is my opinion that both the claim language and the specification compel a construction that the steps be performed in the order recited.

Claim	Claim Language
1[e]	conveying, by transmitting said data packet to said MAC destination address via said first port, said received data packet in said network node to at least said first line card for transmission to said MAC destination address;
1[f]	if said MAC destination address does not appear in said FDB, flooding said data packet via one and only one LAG port of said plurality of LAG ports;
1[g]	checking said MAC source address of the data packet against records in said FDB of said first line card; and
1[h]	if said FDB of said first line card does not contain a record of an association of said MAC source address with said ingress port, creating a new record of said association, adding said new record to the FDB of said first line card, and sending a message of the association to each member line card of said plurality of member line cards.

62. Step 1[e] of conveying the data packet to the first line card must be performed before 1[f] checks the MAC destination address in said FDB and 1[g] checks the MAC source address in said FDB of the first line card. Before the data packet is conveyed, it doesn’t know what the first line card is, and therefore, it could not check the FDB of the first line card. I understand that Corrigent has offered an alternate construction of “said FDB” as “said FDB of said first line card.” Thus, in order to check the FDB of the first line card, the packet must first be conveyed to the first line card before it may be checked. However, if Corrigent also argues that the data packet could not have been conveyed to the first line card unless it first checks an FDB to

know where it should be transmitted, then it must be checking the FDB of the *ingress* line card. If so, then the “said FDB” in 1[f] could not possibly be the said FDB of the first line card, contradicting Corrigent’s proposed construction. I note that this only serves to underscore the indefiniteness of “said FDB” in claim 1[f], because it is unclear which FDB is being checked and nothing in the intrinsic record clarifies the issue. But if I assume the construction that Corrigent proposes, then step 1[e] must be performed before step 1[f], and the data packet must first be conveyed to the first line card in step 1[e] before the data packet is checked in the FDB of the first line card for steps 1[f] and 1[g].

63. And 1[g] of [checking the MAC source address in the FDB of the first line card](#) must be performed before 1[h] of [creating a new record of association in the FDB](#). In order to know whether the FDB contains a record of association of the MAC source address and ingress port (1[h]), the FDB must first have been checked in 1[g]. It would be impossible to know whether the record existed or not as required in 1[h] if the FDB were not first checked in 1[g].

64. Based on my review of the specification, it is fully consistent with the order of steps required by the claims. As discussed above, the ’400 patent clearly delineates between the ingress path and egress path. The ’400 patent explains that “[t]he egress line card (or line cards) that is to transmit the packet onward checks the MAC source address of the data packet against the records in its own FDB.” ’400 patent at 3:18–20. “If the FDB of the transmitting line card [*i.e.*, the egress line card] does not contain a record associating the MAC source address with the port of the ingress line card on which the data packet was received, the transmitting line card adds the record to its FDB.” *Id.* at 3:20–24. The patent expressly notes that “[l]earning on egress is advantageous particularly with respect to flooded packets, since in this case multiple line cards receive the packet and are able to learn the interface association of the MAC source address (SA) and VPLS

instance.” *Id.* at 7:60–63. The data packet is conveyed to the egress line card in step 1[e]. And because MAC learning specifically occurs on the egress path, the packet must first be conveyed to the egress line card in step 1[e] before the MAC learning steps in 1[g] and 1[h] may occur. Corrigent’s arguments that there is nothing that requires the conveying step (1[e]) to be performed before MAC learning (1[g], 1[h]) is therefore incorrect. Both the plain language of the claims and the specification compel that the steps occur in the order proposed by Defendants.

65. Independent claim 11, an apparatus claim, should likewise be construed to require that the steps be performed in the order recited. As explained above, the claim language here clearly contemplates a sequential process.

iv. “conveying ... said received data packet ... to at least said first line card for transmission to said MAC destination address / said ingress line card conveys said data packet ... to at least said first line card for transmission to said MAC destination address” (claims 1, 11)

66. In my opinion these claim limitations, as recited in claims 1 and 11, have the same claim scope, and a POSITA would understand them to mean “conveying the data packet received on an ingress port of an ingress line card to a first line card for transmission to the MAC destination address.”

67. The relevant claim limitations of Claim 1 claim:

receiving a data packet on *an ingress port* of said network node from a MAC Source address, said data packet specifying a MAC destination address on said Layer 2 data network;

conveying, by transmitting said data packet to said MAC destination address via said first port, ***said received data packet*** in said network node ***to at least said first line card for transmission to said MAC destination address;***

The relevant claim limitation of Claim 11 claims:

. . . wherein said line cards are arranged so that upon receiving a data packet on *an ingress line card* from a MAC source address, said data packet specifying a MAC destination address, ***said ingress line card conveys said data packet*** via said switching core ***to at least said first line card for transmission to said MAC destination address*** . . .

68. Dr. Olivier states that a POSITA would easily understand these claim limitations and that Defendants’ construction is unnecessary. Olivier Decl. ¶¶ 57–59. I disagree. While there is no dispute over the fact these limitations require conveying a data packet ***to*** the first line card, claim construction is necessary to clarify that the data packet is conveyed ***from*** an ingress line card containing the ingress port.

69. Dr. Olivier overlooks the difference between claims 1 and 11 and does not address how claims 1 and 11 should be interpreted in light of this difference. Claim 1 states, in relevant portions, that a data packet is received “on an ingress port,” while claim 11 states, in relevant portions, that a data packet is received “on an ingress line card.” In my opinion, the claimed ingress port is necessarily part of the ingress line card, and this opinion aligns with the teachings of the patent. The specification of the ’400 Patent discloses “. . . an ingress line card receives an incoming data packet over the VPN on one of its ports. . . .” ’400 Patent, 3:10-12; see also 6:10–12 (“Line cards 32 have ports 36, which connect to other nodes in LAN 26 and WAN 28 (and possibly in other networks, as well).”). A POSITA would understand that the data packet is received on the ingress port of the ingress line card. Defendants’ construction clarifies the scope of the claim limitation by highlighting that the data packet is conveyed from the ingress line card containing the ingress port.

70. Dr. Olivier states that Defendants' construction eliminates the claimed "switching core" from claim 11. Olivier Decl. ¶ 60. I believe an opinion on the "switching core" is not presently necessary based on the construction provided by Defendants in their responsive brief. To the extent this is not true, I reserve the right to provide a responsive opinion and/or to supplement my declaration.

v. ***"providing for each of said member line cards a respective forwarding database (FDB)" (claim 1)***

71. Dr. Olivier states that a POSITA would understand "that while each line card might include at least one FDB, the claim is not limited to an instance where each line card is limited to only a single FDB." Olivier Decl. ¶ 63. I disagree. The claim limitation "providing for each of said member line cards a respective forwarding database (FDB)" means "providing for each of said member line cards a single forwarding database (FDB)."

72. In the context of the '400 Patent, a POSITA would understand that each line card is limited to a single FDB. The idea of a system where each line card had more than a single FDB has no intrinsic support and adds a layer of complexity that goes well beyond any disclosure in the '400 Patent. A POSITA would not understand the claim language to contemplate a system containing line cards with more than one FDB. In particular, while the specification describes how to send synchronization messages between line cards, it provides no description of how multiple FDBs on a single line card would be synchronized. The '400 Patent discloses "[a]t an appropriate time, the line card sends a synchronization message to the remaining line cards, informing them of the association of the MAC Source address with the ingress port. Typically, all line cards send their synchronization messages at certain predefined times, although under some circumstances, a synchronization message may be sent immediately upon entry of a new association in *the FDB*. Upon receiving the synchronization message, the other line cards update *their own* MAC FDBs as

appropriate. . . . In the absence of the synchronization method described above, other members in the LAG may not receive such packets for transmission, *so that the FDB of the corresponding line cards* will not be updated. When these line cards receive incoming packets, the result may be constant flooding, since *the FDB* is incomplete. The synchronization mechanism described herein avoids this problem by updating *the FDB* in all line cards in the LAG group (or across the entire VPN instance) within the node.” ’400 Patent, 3:26–45. The specification makes it clear that the claimed inventions is implemented with a *single FDB* for each line card and that the success of the claimed invention relies on the existence of this single line card. Further the ’400 Patent discloses, “[i]n order to process a SYNC packet with a new SA at step 64, each line card checks the VPLS instance identified in the packet. If the line card is not configured to serve this VPLS instance, it simply discards the synchronization message. Otherwise, if an entry does not exist for the key fields extracted from the SYNC packet, *the line card adds the record to its own FDB.*” ’400 Patent, 8:31-37. The disclosures in the ’400 Patent make it clear that the embodiments disclosed are systems with line cards that have their own *FDB*, not their own *FDBs*. There is no support in the claim language or the specification for line cards can have more than one FDB. Implementing Plaintiff’s construction would require a POSITA to speculate far beyond the teaching of the ’400 Patent.

73. Dr. Olivier states that Defendants’ construction would be “inconsistent with use of the word ‘respective’ throughout the claims and specification in other contexts” and points to the term “respective ports” in claims 1, 2, and 11. Olivier Decl. ¶ 64. I disagree. The claim scope of “respective ports” do not share any of the same issues noted above, nor are Defendants proposing to construe any instances of the term “respective” beyond the particular instance that recites “providing for each of said member line cards a respective forwarding database (FDB).” In fact,


one of the examples identified by Dr. Olivier provides further support for Arista's proposed construction. Dr. Olivier notes that claim 11, claims "each line card having *respective ports* and having *a respective forwarding database* (FDB)." Olivier Decl. ¶ 64. This language highlights that while the line cards may have multiple respective ports, they only have a single forwarding database, "a respective forwarding database."

V. CONCLUSION

74. Based on all of the foregoing, it is my opinion that Plaintiff's expert's technical errors as well as his misleading and conclusory statements, do not provide evidence in support to Plaintiff's claim constructions.

I declare under penalty of perjury that the foregoing is true and correct.

Executed in Douglas, Massachusetts on February 6, 2024.

By: 

William R. Michalson

ATTACHMENT A

Curriculum Vitae for William R. Michalson

Research Associates, LLC
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1. Personal:

1.1 Education

Ph.D. in Electrical Engineering, 1989, Worcester Polytechnic Institute, Worcester, Massachusetts.

Dissertation: *A Parallel Computer Architecture for Real-Time Decision Making*. The dissertation develops a hierarchical, multiple processor, computer architecture for executing artificial intelligence programs in real-time. Dissertation Directors: Dr. Peter E. Green and Dr. R. James Duckworth.

Minor Areas: Minor sequences completed in Mathematics and Physics.

Specialties: Area examinations passed in the fields of Computer Architecture, Probabilistic Systems Analysis, and State Space Analysis.

M.S. in Electrical Engineering, 1985, Worcester Polytechnic Institute, Worcester, Massachusetts.

Specialties: The courses taken stressed Computer Architecture, Communications Systems, and Solid-State Physics.

B.S. in Electrical Engineering, 1981, Syracuse University, Syracuse, New York.

1.2 Work experiences - Academic.

1991-Present Worcester Polytechnic Institute

Professor of Electrical and Computer Engineering; also holds collaborative appointments as a Professor of Computer Science, a Professor of Mechanical Engineering and a Professor of Robotics Engineering.

Effective Sep, 2016 Granted a collaborative appointment as a Professor of Mechanical Engineering.

Effective July 1, 2005 Promoted to the rank of Full Professor (Professor of Electrical and Professor of Computer Science)

<i>November 17, 2004</i>	Appointed dual professorship, adding the title of Associate Professor of Computer Science.
<i>July 1, 1998</i>	Granted tenure and promoted to the rank of Associate Professor.
<i>August 1, 1992</i>	Assistant Professor of Electrical Engineering (tenure-track).
<i>August 1, 1991</i>	Visiting Assistant Professor of Electrical Engineering.
<i>January 1, 1990</i>	Adjunct Assistant Professor of Electrical Engineering.

1.3 Work experiences other than teaching (chronological).

2012-2014 Grid Roots, LLC

Grid Roots, LLC is a company which was formed in 2012 for the purpose of commercializing a navigation and tracking device for use by children and the elderly to allow caregivers to non-intrusively monitor their activities. The system under development integrates GPS, inertial and beacon-based navigation technologies to develop a system for users to track deployed devices. My responsibilities within Grid Roots, LLC relate to hardware and software engineering, as well as the development of IP related to tracking individuals.

1995-Present Research Associates, LLC

Research Associates, LLC is a company I formed in which I perform engineering and consulting in the areas of computer systems, communications and navigation. All of my litigation-related and other consulting activities are performed through Research Associates, LLC.

1988-1991 Raytheon Company

Subsequent to receiving my Ph. D., I returned to the Equipment Division of the Raytheon Company. Shortly after I returned, I was promoted to a title of Engineer, Design and Development which was the highest title I could hold based on my level of education and years of experience. Within a year, I was selected to sit on the engineering staff of a newly formed System Engineering Department of the Division's Computer and Displays Laboratory. In this department I acted primarily as a consultant to other departments within the laboratory. My responsibilities ranged from leading the hardware/software development of supercomputer-class computer systems to performing applied research into the exploitation of new technology. My role was similar to that of a Principle Investigator in an academic setting as I was responsible for securing funding and personnel, leading research efforts, interacting with the research sponsor, and reporting results. At the time of my departure I was involved with the following projects:

Fault-Tolerant Multiprocessor

The development of a highly fault tolerant, highly reliable, real-time computer system intended for long-duration spaceborne applications. This system is designed to produce in excess of one gigaoperation per second of raw processing power.

Optimal Task Allocation

A program of applied research into the use of Genetic Algorithms for deriving optimal mappings of software tasks to the hardware processing elements in distributed systems.

Performance Modeling and Scaling

This project focused on the development of simulation models for characterizing the performance of a large scale multiple processor system. These models formed a basis for predicting system performance for several different hardware configurations to ensure compliance with system specifications.

High Clutter Signal Detection

A program of applied research into the use of Neural Networks to detect the presence of targets in extremely high clutter environments.

Power Efficient Computing

A program of applied research into an Integrated Optical computer structure that is designed to maximize the number of computations that can be performed per unit of power.

1985-1988 Raytheon Company (Leave of Absence)

In 1985 I became one of two people in the Equipment Division to receive Aldo Miccioli Fellowships. This Fellowship was awarded to allow me to pursue full-time study towards the Ph.D. degree. I returned to Raytheon during the summer of 1986, but otherwise remained on leave of absence to dedicate my time to my studies.

1982-1985 Raytheon Company

Engineer in the VLSI Design Department of the Computer and Displays Laboratory within Raytheon's Equipment Division. I was lead engineer for the design of several semi-custom VLSI circuits for both signal and data processing applications.

1981-1982 Raytheon Company

Engineer in the Cursive Displays Department of the Computer and Displays Laboratory. I designed and debugged circuit assemblies which were used in vector displays for air traffic control applications.

1.4 Consulting experiences.

1.4.1 Law-Related

Textron Innovations INC. v. SZ DJI Technology Co, LTD. et al.

Retained by Baker Botts, LLP as an expert on behalf of plaintiff Textron. Case before the United States District Court for the Eastern District of Texas (Case No. 2:22-cv-351). Retained 6/23.

Geoscope Technologies Pte. Ltd. V. Google LLC

Retained by William & Connolly LLP on behalf of defendant Google. Case before the United States District Court for the Eastern District of Virginia (Case No. 1:22-cv-01331-MSN-IDD). Retained 2/23 – 9/23, Deposed 8/17/23.

American Patents, LLC v. Texas Instruments, Inc., Realtek Semiconductor Corporation and Mediatak Inc.

Retained by Texas Instruments, Realtek, and Mediatek as an expert on defendants. Case before the United States District Court for the Eastern District of Texas – Sherman Division (Case Nos. 4:22-cv-478, 4:22-cv-479, and 4:22-cv-480). Declaration with respect to claim construction 2/10/23). Retained 1/23 – 4/23.

United Services Automobile Association v. Auto Telematics Ltd.

Retained by Fish & Richardson as an expert on behalf of petitioner United Services Automobile Association. Provided declarations in support of multiple IPR filings (IPR2023-00518, IPR2023-00519, IPR2023-00768, IPR2023-00769, IPR2023-00770, IPR2023-00857, IPR2023-00858, IPR2023-00859, IPR2023-00911, and IPR2023-00912). Retained 12/22.

Railware, Inc. v. National Railroad Passenger Corporation dba Amtrak

Retained by Venable, LLP as an expert on behalf of defendant Amtrak. Case before the United States District Court for the Southern District of New York (Case No. 1:22-cv-05013). Provided declarations in support of multiple IPR filings (IPR2023-1179, IPR2023-1180, and IPR2023-1181). Retained 12/22.

Volvo Penta of the Americas, LLC. v. Brunswick Corporation

Retained by Kilpatrick Townsend & Stockton, LLP as an expert on behalf of petitioner Volvo Penta. Provided declarations in support of multiple IPR filings (IPR2022-01366, IPR2022-01367, IPR2022-01368, IPR2022-01369, and IPR2022-01424). Retained 6/22 – 9/23.

Textron Innovations INC. v. SZ DJI Technology Co, LTD. and DJI Europe B.V.

Retained by Baker Botts, LLP as an expert on behalf of plaintiff Textron. Case before the United States District Court for the Western District of Texas (Case No. 6:21-cv-00740-ADA). Retained 2/22 – 4/23, Deposed 1/22/23 and 1/24/23, Testified 4/17-18.

Smartsky Networks, LLC, v. GOGO Business Aviation, LLC and GOGO INC.

Retained by Sidley Austin, LLP as an expert on behalf of defendant Gogo. Case before the United States District Court for the District of Delaware (Case No. 22-266 UNA). Deposed 5/19/22. Retained 3/22.

Via Transportation, Inc. v. RideCo Inc.

Retained by Erise, IP on behalf of defendant RideCo. Case before the United States District Court for the Western District of Texas, (Case No. No. 6:21-cv-00457). Retained 1/22.

BillJCo, LLC v. Cisco Systems, Inc., Apple Inc., Hewlett Packard Enterprise Co. and Aruba Networks, LLC

Retained by the law firms of Merchant & Gould, P.C., DLA Piper, and Greenberg Traurig, LLP Purpose on behalf of their clients Cisco Systems, Inc., Apple Inc., Hewlett Packard Enterprise Co. and Aruba Networks, LLC for the analysis of certain patents relating to methods and systems for location tracking of mobile devices. Submitted declaration related to IPR2022-420 and IPR2022-00427. Retained 12/21 – 6/23.

Mark Adams, Sr., v. Cataldo Ambulance Service, Inc,

Retained by Morrisson Mahoney, LLP on behalf of defendant Cataldo Ambulance Service. Case before Middlesex Superior Court, Commonwealth of Massachusetts, Civil Action No. 19-CV-1931. Retained 10/21.

Omnitracs, LLC et al. v. Platform Science, Inc.

Retained by Fish & Richardson on behalf of defendant Platform Science, Inc. Case before the Federal District Court Southern District of California. Case No. 3:20-cv-0958-JS-MDD. Retained 8/21 – 9/23, Deposed 8/23-24/23.

LoganTree, LP v. Garmin International, Inc. and Garmin USA, Inc.

Retained by ErisIP on behalf of defendant Garmin. Case before the District of Kansas, Case No. 17-cv-01217 2:16-cv-190 involving U.S. Patent No. 6,059,576. Submitted Expert Report on Non-Infringement; Deposed 12/1/21; Testified in Court 10/26/22; Retained 7/21 - 10/22.

Allstate Insurance Company V. Atos, LLC

Retained by Sidley Austin, LLP on behalf of petitioner Allstate Insurance Company challenging the validity of US Patent Nos. 8,527,140; 9,152,609; and 9,846,174 at the Patent Trial and Appeal Board of the U.S. Patent Office. Submitted declarations in IPR2021-01118, IPR2021-01209, and IPR2021-01449. Deposed 3/31/22 and 4/7/22; Retained 2/21 – 1/23.

R&R Packaging, Inc. D/B/A R&R Solutions v. Evenflo Company, Inc.

Retained by Polsinelli on behalf of Plaintiff R&R. Case before the Western District of Arkansas (Fayettevill Division), Case No. 5-20-cv-05095. Submitted Reports on Claim Construction; Deposed 7/21; Retained 11/20.

InfoGation Corporation v. Google LLC.

Retained by O'Melveny & Meyers, LLP as an expert on behalf of defendant Google Inc. Patents-in-suit are U.S. Patents 6,199,014. Case before the United States District Court for the Southern District of California, San Diego Division (Case No. 3:21-CV-00843-H-JLB). Deposed 2/27/13 - 2/28/13. Retained 8/20 to 6/22.

WSOU Investments LLC v. Dell Technologies Inc. et al.

Retained by Gibson-Dunn on behalf of defendant Dell. Case before the United States District Court for the Western District of Texas, (Case Nos. 20-cv-00473-ADA; 20-cv-00474-ADA; 20-cv-00475-ADA; 20-cv-00476-ADA; 20-cv-00477-ADA; 20-cv-00478-ADA; 20-cv-00479-ADA; 20-cv-00482-ADA). Deposed 5/11/23. Retained 7/20 – 6/22.

Apple v. LBS Innovations, LLC.

Retained by ěrise ip on behalf of petitioner Apple, Inc., challenging the validity of U.S. Patent No. 6,091,956 at the Patent Trial and Appeal Board of the U.S. Patent Office, IPR2020-00696. Retained 02/20 – 8/20. Submitted declaration.

Makor Issues & Rights Ltd. v. Google LLC et al.

Retained by Arnold & Porter Kaye Scholer LLP on behalf of defendant Google. Case before the District of Delaware, Case No. 1:16-cv-00100. Retained 12/19.

Intellectual Ventures I, LLC and Intellectual Ventures II, LLC v. NetApp, Inc.

Retained by Gibson Dunn on behalf of defendant NetApp, Inc. Case before the District of Massachusetts, Case No. 1:16-cv-10868-PBS. Retained 09/19. Submitted Expert Reports on Invalidity and Non-Infringement.

Google, LLC v. Traxcell Technologies, LLC.

Retained by Finnegan, Henderson, Farabow, Garrett & Dunner, LLP on behalf of petitioner Google, Inc., challenging the validity of U.S. Patent Nos. 9,918,196 and 10,820,147 at the Patent Trial and Appeal Board of the U.S. Patent Office, IPR2021-01004 and IPR2022-00442. Retained 06/18 – 1/22. Submitted declarations.

Lipton, et al. v. Knight, et al.

Retained by Campbell Conroy & O'Neil, PC on behalf of defendant First Student. Case before the Superior Court of Massachusetts, Plymouth, Case No. PLCV 2014-00528. Retained 05/19-8/19. Submitted Expert Disclosure.

PPS Data, LLC., v. Jack Henry & Associates, Inc.

Retained by Polsinelli on behalf of defendant Jack Henry and Associates. Case before the Eastern District of Texas. Retained 11/18-9/19. Submitted Expert Reports on Invalidity and Non-Infringement; Deposed 5/29/19, testified in Court 9/11/19.

Cisco Systems, Inc. v. TracBeam, LLC.

Retained by Haynes Boone, LLP on behalf of petitioner Google, Inc., challenging the validity of U.S. Patent Nos. 7,525,484 9,277,525, and 7,298,327 at the Patent Trial and Appeal Board of the U.S. Patent Office, IPR2018-01722 - IPR2018-01728. Retained 06/18. Submitted declarations.

Burris Company, Inc. v. Garmin International, Inc.

Retained by Shook Hardy and Bacon on behalf of defendant Garmin. Case before the District of Oregon, Case No. 6:18-CV-00700. Submitted Declaration wrt Invalidity; Testified in Court (PI hearing) 07/11/18; Retained 04/18-08/18.

American GNC Corporation v. LG Electronics Inc., LG Electronics Mobilecomm U.S.A., Inc., and LG Electronics Mobile Research U.S.A., LLC.

Retained by White & Case on behalf of defendant LG. Case before the Southern District of California, Case No. 3:17-CV-01090-BAS-BLM. Retained 11/17. Submitted Declaration wrt Claim Construction; Deposed 1/18.

Qualcomm v. Apple

Retained by Quinn-Emanuel on behalf of plaintiff Qualcomm. Case before the Southern District of California, Case Nos. 3:17-cv-00108-GPC-MDD and 3:17-cv-01010-GPC-MDD. Retained 10/17-5/19; Submitted Expert Report; Deposed 10/18.

Samantha Ingram v. New England Beauty Academy, LLC a/k/a Toni&Guy Hairdressing Academy, Newell Rubbermaid INC. and Goody Products, INC. d/b/a Solano.

Retained on behalf of plaintiff Samantha Ingram. Case before the Worcester Superior Court, Commonwealth of Massachusetts, Civil Action 1385CV02129D. Retained 09/17-09/18; Submitted Expert Disclosure.

FISERV, INC., Jack Henry & Associates, Inc., Q2 Software, Inc., American National Bank of Texas and Hanmi Bank, Petitioners v. Mirror Imaging LLC., Patent Owner.

Retained by Polsinelli on behalf of petitioners to provide declarations for multiple petitions for covered business methods review. See CBM2018-00012, CBM2018-00014, and CBM2018-00015. Retained 1/18-03/18.

Accelaron v. Dell Inc.

Retained by Baker Botts on behalf of defendant Dell. Case before the Northern District of Georgia, Case No. 1:12-cv-04123-TCB. Submitted Expert Reports related to Claim Construction, Invalidity and Non-Infringement; Deposed 10/13/17 and 6/20/19; Trial 9/6/21 to 9/17/21; Retained 7/17 to 9/21.

Omega Patents, LLC v. CalAmp Corp.

Retained by Sidley Austin on behalf of defendant CalAmp. Case before the Middle District of Florida, Case No. 6:13-cv-1950 involving U.S. Patent Nos. 6,346,876; 6,756,885; 7,671,727 and 8,032,278. Retained 5/17 to 12/17.

Unified Patents, Inc.

Retained by Unified Patents to provide declarations for multiple petitions for *inter partes* review related to patents U.S. Patent No. 7,650,234 and 8,538,498. Retained 03/17-05/17.

Garmin Switzerland GmbH, and Garmin Corporation v. Navico Inc., C-MAP USA, Inc., and C-MAP/Commercial, Ltd.

Retained by Shook, Hardy & Bacon, L.L.P. on behalf of plaintiff Garmin. Case before the District of Kansas, Case No. 16-cv-2706 involving U.S. Patent Nos. 7,268,703 and 6,459,987. Submitted Declaration On Claim Construction; Deposed 12/21/17; Retained 10/16 to 02/18.

Navico Inc. and Navico Holdings AS, v. Garmin International, Inc. and Garmin USA, Inc.

Retained by Paul Weiss on behalf of defendant Garmin. Case before the Eastern District of Texas, Case No. 2:16-cv-190 involving U.S. Patent Nos. 9,223,922 and 9,244,168. Submitted Expert Report on Non-Infringement; Deposed 12/14/16, 5/25/17; Testified in Court 9/7/17; Retained 8/16 to 9/17.

Orbcomm, Inc. v. CalAmp Corp.

Retained by Sidley Austin on behalf of defendant CalAmp. Case before the Eastern District of Virginia, Case No. 3:16-cv-208 involving U.S. Patent Nos. 6,292,724, 6,611,686, 6,651,001, 6,735,150, and 8,855,626. Expert Declaration on Claim Construction, Reports on Invalidity and Non-Infringement; Retained 5/16 to 2/17.

Navico Inc. and Navico Holdings AS, v. Garmin International, Inc. and Garmin USA, Inc.

Retained by Paul Weiss on behalf of defendant Garmin. Case before the Northern District of Oklahoma, Case No. 14-cv-303 involving U.S. Patent Nos. 8,300,499, 8,305,840, and 8,605,550. Deposed 11/8/15; Retained 10/15 to 10/17.

Johnson Outdoors Inc. and Johnson Outdoors Marine Electronics, Inc., v. Garmin International, Inc. and Garmin USA.

Retained by Paul Weiss on behalf of defendant Garmin. Case before the Middle District of Alabama, Case No. 14-cv-683 involving U.S. Patent Nos. 7,652,952, 7,710,825, and 7,755,974. Retained 10/15 to 5/16. Case dismissed.

Google, Inc. v. Silver State Intellectual Technologies, Inc.

Retained by Paul Hastings on behalf of petitioner Google, Inc. to provide declarations for multiple petitions for *inter partes* review. See IPR2015-01737 and IPR2015-01738. Retained 10/15 to 12/15.

Vehicle IP LLC v. AT&T Mobility, LLC, et al.

Retained by Akin Gump and by Perkins-Coie on behalf of defendants AT&T Mobility LLC; Cellco Partnership; Networks In Motion, Inc.; TeleCommunications Systems, Inc.; and Telenav Inc. Case before the District of Delaware, Case No. 1:09-cv-01007-LPS involving U.S. Patent No. 5,987,377. Expert Report on Invalidity; Deposed 5/20/16; Retained 9/15 to 1/17. Matter settled.

TracBeam, L.L.C. v. T-Mobile US, Inc., et al.,

Retained by Baker Botts on behalf of defendant T-Mobile US, Inc., et al. Case before the Eastern District of Texas (6:14-cv-678-RWS). See also IPR2015-01681, IPR2015-01682, IPR2015-01684, IPR2015-01686, IPR2015-01687, IPR2015-01708, IPR2015-01709, IPR2015-01711, IPR2015-01712, and IPR2015-01713. Expert Report on Invalidity; Deposed 10/04/16; Retained 7/15 to 12/16. Matter settled.

Google, Inc. v. Porto Technology Co., Ltd.

Retained by Fish and Richardson on behalf of petitioner Google, Inc., patent owner Porto Technology Inc. IPR2016-00022 and IPR2016-00045. Expert Declarations; Deposed: 7/14/16 (IPR2016-00022); 7/14/16 (IPR2016-00045). Retained 7/15 to 7/20.

Bradium Technologies LLC v. Microsoft Corporation,

Retained by Perkins Coie on behalf of defendant Microsoft Corporation. Case before the District of Delaware (15-0031-RGA). See also IPR2015-01432, IPR2015-01434, IPR2015-01435, IPR2016-00448 and IPR2016-00449. Expert Declarations; Deposed 8/5/16, 02/21/17; (IPR2015-01432); Retained 3/15 to 10/17.

ACQIS LLC v. EMC Corp.,

Retained by Gibson Dunn on behalf of defendant EMC Corp. Case before the District of Massachusetts (1:14-cv-13560). Expert Report on Invalidity; Retained 2/15 to 2/21.

Locata LBS LLC v. YellowPages.com LLC,

Retained by Baker Botts on behalf of defendant YellowPages.com. Case before the Central District of California (2:13-cv-07664). See also IPR2015-00151. Submitted Declaration. Retained 9/14 to 4/15. Matter settled.

M/A-COM Technology Solutions Holdings, Inc. v. Laird Technologies, Inc.

Retained by Erise IP on behalf of Laird Technologies, Inc., for invalidity consulting regarding U.S. Patent No. 6,272,349. Retained 6/14 to 9/14.

Certusview Technologies, LLC v. S&N Locating Services, LLC and S&N Communications, Inc.,

Retained by Baker & McKenzie on behalf of defendant S&N. Patents-in-suit are U.S. Patents 8,265,344, 8,290,204, 8,340,359, 8,407,001, and 8,532,341. Case before the Eastern District of Virginia, (2:13-cv-346). Expert Report on Non-Infringement; Deposed 11/8/14; Retained 6/14 to 12/14.

adidas AG and adidas America, Inc. v. Under Armour, Inc. and MapMyFitness, Inc.

Retained by Kilpatrick Townsend on behalf of plaintiff adidas. Case before the District of Delaware, (1:14-cv-00130). See also IPR2015-00697, IPR2015-00698, and IPR2015-00700. Deposed: 10/21/16 and 10/22/16 relative to 1:14-cv-00130; 2/5/16 relative to IPR2015-00697; 2/5/16 relative to IPR2015-0068; 2/5/16 relative to IPR2015-0700. IPR Declarations, Expert Report on Validity; Deposed 02/05/16; Retained 5/14 to 7/16.

GeoTag, Inc., v. AT&T Mobility LLC and AT&T Services, Inc.,

Retained by Baker Botts as an expert on behalf of defendant AT&T. Patent-in-suit is U.S. Patent 5,930,474. Case before the Northern District of Texas, Dallas Division, (3:13-cv-00169). Expert Report on Invalidity; Deposed 5/29/14; Retained 1/14 to 9/14. Matter settled.

Nokia Corp v. HTC Corp.

Retained by Quinn Emanuel as an expert on behalf of defendant HTC. Case being litigated in Germany. Patent number EP0766811B1. Retained 12/13 to 2/14. Matter settled.

Porto Technology, Co., Ltd. et al. v. Cellco Partnership d/b/a Verizon Wireless

Retained by Wiley-Rein as an expert on behalf of defendant Verizon. Case before the United States District Court for the Eastern District of Virginia (Case No. 3:13-cv-00265). Declaration ISO Claim Construction and Summary Judgement of Invalidity; Expert Report on Invalidity; Retained 10/13 to 2/14. Matter dismissed.

Nokia Corp v. HTC Corp.

Retained by McDermott Will and Emery and White & Case as an expert on behalf of defendant HTC. Case before the United States District Court for the District of Delaware (Case No. Case No. 1:12-cv-00550-UNA and Case No. 1:12-cv-551-UNA. Retained 6/13 to 2/14. Matter settled.

NXP B.V. v. Research In Motion, Ltd., et al.

Retained by Fish and Richardson as an expert on behalf of defendant Research In Motion. Patent-in-suit is U.S. Patent 6,501,420. Case before the United States District Court for the

Middle District of Florida (Case No. 6:12-cv-00498). Expert Report on Invalidity, Expert Report on Non-Infringement; Deposed 9/18/13; Testified in Court: 4/1/14 and 4/2/14; Retained 5/13 to 4/14.

Vehicle IP LLC v. Wal-Mart Stores Inc., et al.

Retained by Polsinelli-Shugart, as an expert on behalf of defendant Werner Enterprises. Patent-in-suit is U.S. Patent 5,694,322. Case before the United States District Court for the District of Delaware (Case No. 1:10-cv-00503). Expert Report on Invalidity, Expert Report on Non-Infringement; Deposed 7/15/13 and 9/20/13; Testified in Court: 9/27/13 and 9/30/13; Retained 4/13 to 9/13.

Commonwealth Scientific and Industrial Research Organisation v. Realtek Semiconductor Corporation

Retained by Sidley Austin, LLP as an expert on behalf of defendant Realtek Semiconductor Corporation. Patent-in-suit is U.S. Patent 5,487,069. Case before the United States District Court for the Eastern District of Texas (Tyler Division) (Case No. 6:12-cv-00578). Expert Report on Invalidity, Expert Report on Non-Infringement; Deposed 3/6/15; Retained 4/13 to 4/15. Matter settled.

TracBeam, LLC v. Google Inc.

Retained by Quinn-Emanuel as an expert on behalf of defendant Google. Patents-in-suit are U.S. Patents 7,764,231 and 7,525,484. Case before the United States District Court for the Eastern District of Texas (6:11-cv-00093). Deposed 2/5/14; Retained 3/13 to 6/14.

Microsoft Corporation and Google Inc., v. GeoTag, Inc.

Retained by Perkins-Coie as an expert on behalf of plaintiff Microsoft Corporation. Patent-in-suit is U.S. Patents 5,930,474. Case before the United States District Court for the District of Delaware (1:11-cv-00175). Retained 1/13 to 9/14.

GeoTag, Inc., v. Frontier Communications Corp., et al.,

Retained by multiple firms as an expert on behalf of defendants. Patent-in-suit is U.S. Patents 5,930,474. Case before the Eastern District of Texas, Marshall Division, (2:10-cv-00265; other defendants are listed in case numbers 2:10-cv-00265, 2:10-cv-00272, 2:10-cv-00437, 2:10-cv-00569, 2:10-cv-00570, 2:10-cv-00571, 2:10-cv-00572, 2:10-cv-00573, 2:10-cv-00574, 2:10-cv-00575, 2:10-cv-00587, 2:11-cv-00175, 2:11-cv-00404, 2:11-cv-00421, 2:11-cv-00424, 2:11-cv-00425, 2:11-cv-00570, 2:12-cv-00043, 2:12-cv-00051, 2:12-cv-00436, 2:12-cv-00438, 2:12-cv-00439, 2:12-cv-00441, 2:12-cv-00442, 2:12-cv-00444, 2:12-cv-00445, 2:12-cv-00446, 2:12-cv-00447, 2:12-cv-00448, 2:12-cv-00449, 2:12-cv-00450, 2:12-cv-00452, 2:12-cv-00454, 2:12-cv-00456, 2:12-cv-00459, 2:12-cv-00460, 2:12-cv-00462, 2:12-cv-00464, 2:12-cv-00466, 2:12-cv-00468, 2:12-cv-00469, 2:12-cv-00470, 2:12-cv-00471, 2:12-cv-00473, 2:12-cv-00474, 2:12-cv-00475, 2:12-cv-00476, 2:12-cv-00476, 2:12-cv-00477, 2:12-cv-00480, 2:12-cv-00481, 2:12-cv-00482, 2:12-cv-00482, 2:12-cv-00483, 2:12-cv-00486, 2:12-cv-00487, 2:12-cv-00520, 2:12-cv-00521, 2:12-cv-00523, 2:12-cv-00524, 2:12-cv-00525, 2:12-cv-00527, 2:12-cv-00528, 2:12-cv-00530, 2:12-cv-00532, 2:12-cv-00534, 2:12-cv-00535, 2:12-cv-00536, 2:12-cv-00537, 2:12-cv-00542, 2:12-cv-00543, 2:12-cv-00545, 2:12-cv-00547, 2:12-cv-00548, 2:12-cv-00549, 2:12-cv-00550, 2:12-cv-00551, 2:12-cv-00552, 2:12-cv-00555, 2:12-cv-00556, 2:12-cv-00570, 2:12-cv-

00572, 2:12-cv-00573, 2:12-cv-00575, 2:12-cv-00587, 3:13-cv-00217). Deposed 5/29/14; Retained 1/13 to 9/14.

MOSAID Technologies Inc., v. Realtek Semiconductor Corporation

Retained by Sidley Austin, LLP as an expert on behalf of defendant Realtek Semiconductor Corporation. Patents-in-suit are U.S. Patents 5,131,006; 5,151,920; 5,422,887; 5,706,428; 6,563,786; and 6,992,972. Case before the United States District Court for the Eastern District of Texas (Tyler Division) (Case No. 2:11-cv-00179). Retained 12/12 to 12/12. Matter settled.

Hoyt A. Flemming v. Cobra Electronics Corporation

Retained by Sidley Austin, LLP as an expert on behalf of defendant Cobra Electronics Corporation. Patents-in-suit are U.S. Patents RE39038, RE40653 and RE41905. Case before the United States District Court for the District of Idaho (Case No. 1:12-cv-00392). Retained 11/12 to 06/13. Matter settled.

LBS Innovations LLC v. Aaron Bros., Inc., et al.

Retained as an expert on behalf of defendants Whole Foods Marketplace, Comerica, Hotels.com, Academy, Ltd., and Homestyle Dining. Patent-in-suit is U.S. Patent 6,091,956. Case before the Eastern District of Texas, Marshall Division, (Case No. 2:11-cv-00142-MHS-CMC. Deposed 10/5/12; Retained 7/12 to 12/12. Plaintiff moved to dismiss.

Advanced Media Networks, L.L.C. v. Gogo LLC et al.

Retained by Sidley Austin, LLP as an expert on behalf of defendant Gogo. Patent-in-suit is U.S. Patent 5,960,074. Case before the United States District Court for the Central District of California (Case No. 11-cv-10474). Deposed 2/6/13. Retained 7/12 to 8/13.

Walker Digital, LLC v. Google Inc.

Retained by O'Melveny & Meyers, LLP as an expert on behalf of defendant Google Inc. Patents-in-suit are U.S. Patents 6,199,014. Case before the United States District Court for the District of Delaware (Case No. 1:11-cv-00309-SLR). Deposed 2/27/13 - 2/28/13. Retained 6/12 to 8/13.

Silver State Intellectual Technologies, Inc. v. Garmin International, Inc., et al.

Retained by Erise IP, P.A. as an expert on behalf of defendants Garmin International, Inc. and Garmin USA, Inc. Patents-in-suit are U.S. Patents 6,525,768; 6,529,824; 6,542,812; 7,343,165; 7,522,992; 7,593,812; 7,650,234; 7,702,455 and 7,739,039. Case before the United States District Court for the District of Nevada (Case No. 2:11-cv-1578). Deposed 2/19/14; Testified in Court: 5/21/15; Retained 4/12 to 5/15.

Beacon Navigation GmbH v. Toyota Motor Corporation, et al.

Retained by Kirkland & Ellis, LLP on behalf of defendants Toyota Motor Corporation; Toyota Motor North America, Inc.; Toyota Motor Sales, U.S.A. Inc.; Toyota Motor Engineering & Manufacturing North America, Inc.; Toyota Motor Manufacturing, Indiana, Inc.; Toyota Motor Manufacturing, Kentucky, Inc.; Toyota Motor Manufacturing Mississippi, Inc.; Mazda Motor Corporation; Mazda Motor of America, Inc.; Fuji Heavy Industries, Ltd.; Fuji Heavy Industries U.S.A. Inc.; Subaru of America, Inc.; Jaguar Land Rover North America, LLC; Jaguar Cars

Limited; Land Rover; Volvo Car Corporation; and Volvo Cars of North America, LLC; Adduci Mastriani & Schaumberg, LLP on behalf of defendants Suzuki and Garmin; Crowell-Moring on behalf of General Motors; Dickstein Shapiro on behalf of Chrysler Group, LLC; Finnegan, Henderson, Farabow, Garrett & Dunner on behalf of Bayerische Motoren Werke AG, BMW of North America, LLC, and BMW Manufacturing Co. LLC; Fish & Richardson on behalf of Honda Motor Co., Ltd., Honda North America, Inc., American Honda Motor Co., Inc., Honda Manufacturing of Alabama, LLC, Honda Manufacturing of Indiana, LLC, and Honda of America, Mfg., Inc.; Frommer Lawrence and Haug, LLP on behalf of Dr. Ing. h.c.F. Porsche AG and Porsche Cars North America, Inc.; Hogan Lovells on behalf of Daimler AG, Mercedes-Benz USA, LLC, or Mercedes-Benz U.S. International, Inc.; Quinn-Emanuel on behalf of Nissan and Ford. Case before the US International Trade Commission, Washington D.C., in the matter of: “Certain Automotive Navigation Systems, Components Thereof, and Products Containing Same, Inv. No. 337-TA-814. Case withdrawn by Plaintiff. Retained 1/12 – 4/12.

Beacon Navigation GmbH v. Toyota Motor Corporation, et al.

Retained by Kirkland & Ellis, LLP on behalf of defendants Toyota Motor Corporation; Toyota Motor North America, Inc.; Toyota Motor Sales, U.S.A. Inc.; Toyota Motor Engineering & Manufacturing North America, Inc.; Toyota Motor Manufacturing, Indiana, Inc.; Toyota Motor Manufacturing, Kentucky, Inc.; Toyota Motor Manufacturing Mississippi, Inc.; Mazda Motor Corporation; Mazda Motor of America, Inc.; Fuji Heavy Industries, Ltd.; Fuji Heavy Industries U.S.A. Inc.; Subaru of America, Inc.; Jaguar Land Rover North America, LLC; Jaguar Cars Limited; Land Rover; Volvo Car Corporation; and Volvo Cars of North America, LLC. Multiple cases before the United States District Court for the District of Delaware. Case numbers 1:11-cv-00942-UNA, 1:11-cv-00941-UNA, 1:11-cv-00951-UNA, 1:11-cv-00952-UNA, 1:11-cv-00936-UNA, 1:11-cv-00937-UNA, 1:11-cv-00955-UNA, 1:11-cv-00959-UNA, and 1:11-cv-00960-UNA. Currently stayed. Retained 1/12.

Beacon Wireless Solutions, Inc., et al., v. Garmin International, Inc., et al.

Retained by Shook, Hardy and Bacon, LLP as an expert on behalf of defendant Garmin. Matter involves alleged trade secret misappropriation. Case before the United States District Court for the Western District of Virginia, Harrisonburg Division (Case No. 5:11-cv-00025). Testified in Court: 5/25/12. Retained 12/11 to 5/25/12.

Tramontane IP, LLC v. Garmin Int'l, Inc., et al.

Retained by Shook, Hardy and Bacon, LLP as an expert on behalf of defendant Garmin. Patents-in-suit are U.S. Patents 6,526,268 and 7,133,775. Case before the United States District Court for the Eastern District of Virginia (Case No. 1:2011-cv-00918). Case Settled. Retained 11/11 to 12/11.

Sourceprose, Inc. v. AT&T, Inc., MetroPCS Communications, Inc., et al.

Retained by Kilpatrick Townsend as an expert on behalf of defendant AT&T. Patents-in-suit are US Patent Nos. 7,142,217 and 7,161,604. Case before the United States District Court for the Western District of Texas, Austin Division. Case number 1:11-cv-00117. Retained 11/11 to 3/16.

Furuno Electric Co., Ltd. and Furuno U.S.A., Inc. v. Honeywell International, Inc.

Retained by Quinn-Emanuel as an expert on behalf of complainant Furuno. Case before the US International Trade Commission, Washington D.C., in the matter of: "Certain GPS Navigation Products, Components Thereof, and Related Software," Investigation number 337-TA-810. Patents-in-suit are U.S. Patent Nos. 6,084,565; 7,095,367; 7,089,094; and 7,161,561. Case settled. Retained 8/11 – 12/11.

Honeywell International, Inc. v. Furuno Electric Co., Ltd. and Furuno U.S.A., Inc.

Retained by Quinn-Emanuel as an expert on behalf of respondent Furuno. Case before the US International Trade Commission, Washington D.C., in the matter of: "Certain GPS Navigation Products, Components Thereof, and Related Software," Investigation number 337-TA-783. Patents-in-suit are U.S. Patent Nos. 7,209,070; 6,865,452; 5,461,388; and 6,088,653. Case Settled. Retained 8/11 – 12/11.

Triangle Software, Inc. v. Garmin International, Inc.

Retained by Weil, Gotshal & Manges, LLP., as an expert on behalf of defendant Garmin. Patents-in-suit are US Patents 7,557,730, 7,221,287, 7,375,649, 7,508,321 and 7,702,452. Case before the United States District Court, Eastern District of Virginia, Case No. 1:10-cv-1457 CMH/TCB. Deposed 7/28/11; Testified in Court: 11/3/11 (jury trial). Retained 4/11 to 11/11.

Garmin International, Inc. v. Pioneer Corporation and Pioneer Electronics (USA), Inc.

Retained by Shook, Hardy and Bacon, LLP as an expert on behalf of plaintiff Garmin. Patents-in-suit are U.S. Patents 5,365,448; 5,424,951; and 6,122,592. Case before the United States District Court for the District of Kansas. Case No. 10-CV-2080 JWL/GLR. Declarative Judgment action stayed. Retained 3/11 to 11/11.

Visteon Global Technologies, Inc. And Visteon Technologies, LLC v. Garmin International, Inc.

Retained by Shook, Hardy and Bacon as an expert on behalf of defendant Garmin. Patents-in-suit are US Patents 5,544,060, 5,654,892, 5,832,408, 5,987,375 and 6,097,316. Case before the United States District Court, Eastern District of Michigan, Case No. 2:10-cv-10578--PDB-MAR. Deposed 10/9/12; Retained 12/10 to 10/17.

Thomson Licensing SAS and Thomson Licensing, LLC. v. Realtek Semiconductor Corporation

Retained by Sidley-Austin as an expert on behalf of respondent Realtek Semiconductor. Case before the US International Trade Commission, Washington D.C., in the matter of: "Certain Liquid Crystal Display Devices, Including Monitors, Televisions, Modules, And Components Thereof," Investigation number 337-TA-741. Patent-in-suit is US Patent 6,121,941. Deposed 6/29/11; Testified in Court: 9/15/11 and 9/16/11. Retained 11/10 – 9/11.

Ambato Media, LLC. v. Clarion Co., LTD., et al.

Retained by Traurig-Greenberg as an expert on behalf of defendant Garmin. Patent-in-suit is US Patent 5,432,542. Case before the United States District Court for the Eastern District Of Texas, Marshall Division. Case number 2:09-CV-242. Deposed 4/26/12 and 5/10/12; Testified in Court: 7/11/12. Retained 10/10 to 7/12.

Gabriel Technologies Corporation and Trace Technologies, LLC, v. Qualcomm Incorporated, Snaptrack, Inc. and Norman Krasner

Retained by Cooley-Godward as an expert on behalf of defendants Qualcomm, Snaptrack, and Krasner. Trade secret misappropriation case related to US Patents 6,377,209, 6,583,757, 6,661,372, 6,799,050, 6,861,980, 6,895,249, 7,254,402, 7,289,786, 7,319,876, 7,421,277, 7,446,655, 7,570,958, 7,574,195, and 7,660,588. Case before the Southern District of California San Diego Division, Case No. 08-cv-1992 MMA POR. Retained 6/10 to 7/12.

SiRF/CSR v. Global Locate/Broadcom Corporation

Retained by Wilmer-Hale as an expert on behalf of defendant Global Locate / Broadcom. Patents-in-suit are US Patents 5,663,735, 6,480,150, 6,519,466, 6,650,879, 6,882,827, 6,934,322, 7,412,157, 7,236,883, and 7,573,422. Case before the Central District of California, Case No. 8:06-cv-01216 and Case No. 8:10-cv-01281. Retained 9/10 to 1/11.

Pioneer Electronics v. Garmin Corporation

Retained by Shook, Hardy and Bacon, LLP as an expert on behalf of respondent Garmin In the matter of Certain Multimedia Display and Navigation Devices and Systems, Components Thereof, and Products Containing Same; Inv. No. 337-TA-694. Patents-in-suit are U.S. Patents 5,365,448; 5,424,951; and 6,122,592. Case before the U.S. International Trade Commission. Deposed on 7/29/10; Testified at technology tutorial (8/27/10) and in the evidentiary hearing (9/20/10). Retained 4/10 to 9/10.

EMSAT Advanced Geo-Location Technology, LLC and Location Based Services LLC, v. AT&T Mobility, LLC

Retained by Baker-Botts as an expert on behalf of defendant AT&T Mobility, LLC. Patents-in-suit are U.S. Patents 7,289,763; 5,946,611; 6,324,404; and 6,847,822. Case before the U.S. District Court for the Northern District of Ohio, Eastern Division, Civil Action No. 4:08 CV 822. Deposed 5/4/10; Testified in Court: 5/10/10 (Markman hearing). Retained 12/09 to 3/11.

Tendler Cellular of Texas, LLC v. AT&T Mobility, LLC, et al.

Retained by Baker-Botts as an expert on behalf of defendants AT&T Mobility, LLC, et al. Patents-in-suit are U.S. Patents 7,447,508; 7,305,243; 7,050,818; and 6,519,463. Case before the U.S. District Court for the Eastern District of Texas (Tyler), Civil Action No. 6:09-CV-00115. Retained 8/09 to 7/10.

Ambit Corporation v. Delta Air Lines, Inc., and Aircell LLC.

Retained by Sidley Austin, LLP., as an expert on behalf of defendants Delta Airlines, Inc., and Aircell, LLC. Patent-in-suit is US patent 7,400,858. Case before the US District Court, District of Massachusetts, Boston, Civil Action No. 1:09-CV-10217-WGY. Deposed 12/4/09; Testified in Court: 12/7/09 (evidentiary hearing), 7/10 (jury trial). Retained 8/09 to 7/10.

GPS Industries, Inc. and Optimal I.P. Holdings, L.P. v. Altex Corporation, et. al.

Retained by Hitchcock-Evert as an expert on behalf of defendants Altex Corporation, Deca International Corporation, Golflogix, Inc. and L1 Technologies. Patent-in-suit is US patent 5,364,093. Case before the US District Court, Northern District of Texas, Dallas Division, Civil Action No. 3-07-CV0831-K. Deposed 6/30/09. Retained 5/08 through 7/09.

Satellite Tracking of People, LLC v. Omnilink Systems, Inc.

Retained by DLA Piper as an expert on behalf of defendant Omnilink Systems, Inc.. Patent-in-suit is US patent RE39,909. Case before the US District Court, Eastern District of Texas, Marshall Division, Civil Action No. 2-08CV-116. 12/08 – 1/11.

SiRF Technology, Inc. v. Global Locate, Inc.

Retained by DLA Piper/WilmerHale as an expert on behalf of Global Locate. Patents-in-suit include US patents 6,304,216; 6,417,801; 6,606,346; 6,651,000; 6,704,651; 6,937,187; 7,043,363; 7,091,904; 7,132,980 and 7,158,080. Case before the US International Trade Commission, Washington D.C., in the matters of: “Certain GPS Devices and Products Containing Same,” Investigation number 337-TA-602 (Global Locate, plaintiff) and “Certain GPS Chips, Associated Software and Systems, and Products Containing Same,” Investigation number 337-TA-596 (SiRF Technologies, plaintiff). My work focused on the 7,043,363 and 7,091,904 patents in defense of Global Locate/Broadcom from June 2007 through March 2008. Deposed 1/18-1/19/08; testified at trial 3/18-3/19/08.

Intellectual Science and Technology

Retained Dykema Gossett, PLLC as a technical expert on patent infringement issues related to “suspend-to-RAM” technologies in personal computers. Pre-litigation work.

Intellectual Science and Technology, Inc., v. Sony, JVC and Panasonic

Retained Dykema Gossett, PLLC as a technical expert on patent infringement issues related to US Patent 5,748,575, US Patent 6,222,799, US Patent 6,785,198, US Patent 6,662,239 and US Patent 6,717,890. Sony Electronics Inc., case number 2:06-CV-10406, JVC Americas Corp., case number 2:06-CV-10409 and Panasonic Corporation of North America case number 2:06-CV-10412. Cases heard in United States District Court, Eastern District of Michigan, Southern Division. Expert for Intellectual Science and Technology, Inc. Dec 2006 – 2008..

Kirsch Technologies v. Xerox, Canon

Retained Dykema Gossett, PLLC as an Expert Witness on patent infringement issues related to US Patent 4,816,911, Canon case number CA 00-72775, Xerox case number CA 00-72778, cases heard in United States District Court, Eastern District of Michigan, Southern Division. Expert for Kirsch Technologies. Nov 2006 – 2008..

American Video Graphics v. ATI Technologies

Retained by Sidley, Austin, Brown & Wood, Dallas, TX as a technical expert on patent infringement issues related to US Patents 5,132,670, 5,109,520, 5,084,830, 4,761,642, 4,742,474, 4,734,690, 4,730,185 and 4,694,286. Hewlett-Packard Co., et al., defendants, case number CA 6:04-CV-379-LED and Sony Corporation of America et al., defendants, case number CA 6:04-CV-399-LED. Cases heard in United States District Court, Eastern District of Texas, Tyler Division. Expert for ATI Technologies, intervener. Jan 2005 – Sep 2005.

Microsoft v. EMC

Dewey Ballantine, LLP, Washington, D.C., as a technical expert on patent infringement issues related to US Patents 5,588,147; 5,689,700; 6,393,466; 6,424,151; 6,490,594; and 6,632,248. Wrote a declaration on behalf of Microsoft. Oct 2004 – Jan 2005.

Optimum Return v. Meier Brothers

Retained by Sidley, Austin, Brown & Wood, Dallas, TX as a technical expert on Copyright infringement allegations related to software owned by Optimum Return, LLC. Cyberkatz Consulting, Inc., Handsquare, LLC, Meier Brothers, et al., defendants, case number CA 3-03CV1064-D. Case heard in United States District Court, Northern District of Texas, Dallas Division. Expert for Meier Brothers. July 2004.

Parental Guide of Texas, Inc. v. Funai Corp., et. al.

Technical expert for defendants JVC and Panasonic in their dispute over non-infringement of US Patent number 4,605,964.

Elonex I.P. Holdings, LTD. and Elonex PLC, Phase II

Expert witness for defendants Chuntex, Acer, Tatung, Lite-On, Daewoo and Envision in their dispute with Elonex non-infringement and validity for US Patent numbers 5,389,952; 5,648,799; and 5,880,719.

Storage Computer Corporation vs. Veritas Software

Technical expert for the plaintiff in matters involving Patents US 5,257,367; US 5,893,919; and US 6,098,128.

Storage Computer Corporation vs. Seagate Technology LLC

Technical expert for the defendant in matters involving US Patent RE 34,100.

Elonex I.P. Holdings, LTD. and Elonex PLC, vs. Packard Bell et. al., CA 98-689-GMS

Expert witness for defendants ViewSonic Corp., Dell Computer Corporation, MAG Technology USA, Princeton Graphic Systems, Inc., Micron Electronics, Sony Electronics and Capetronic Computer USA in their dispute with Elonex non-infringement and validity for US Patent numbers 5,389,952; 5,648,799; and 5,880,719.

1.4.2 Engineering Consulting

BLS, LLC

Member and technical consultant for developing technologies related to firearm safety. 10/22.

Offspring Media Inc.

Technical consultant for the development of real-time auralization algorithms for integration into a consumer electronics product. Sep 2004.

Raytheon Company, Sudbury, MA

Development of techniques and requirements for implementing a fault tolerant computer system using software implemented fault tolerance (SIFT) techniques on commercial off-the-shelf

processing hardware. The resultant system is to be used for highly reliable radar data and signal processing.

TVM Techno Venture Management

Provided consulting services to assist in assessing the technical claims of a company pursuing venture capital investment for a hardware implemented RAID 5 system .

Keyhold Engineering Inc., Northboro, MA.

Development of a prototype system for automatically calibrating multiple channel audio systems.

American Navigation Systems Inc., Milbury, MA.

Consulting on the development of the hand-held personal navigation and mapping system.

Lincoln Laboratory, Bedford, MA.

Simulated, tested and evaluated a GPS integrity monitoring algorithm developed at Lincoln Laboratories.

1.5 Licenses and Certifications

1.5.1 Commercial Radio Operator

General Radiotelephone Operator License
Ship RADAR endorsement

1.5.2 Amateur Radio Operator

Amateur Extra class radio operator license.

1.5.3 Diving Certifications

PADI Open Water Diver (ISO 24801-2 Diver Level 2 – Autonomous Diver)

1.5.4 Other Certifications

Remote Pilot Certificate (FAA Part 107 Small UAs)

2. Courses Taught at WPI

2.1 Course Descriptions

Short descriptions of the courses taught are as follows:

EE572N Advanced System Architecture

This course focuses on the architectural techniques used to achieve high-performance in SISD and SIMD computer systems. In this course the interaction between the software application and hardware architecture and the effect of this interaction on achievable performance is stressed. The course begins by covering the basic architectural tricks used to enhance system performance and ends with a series of case studies that analyze specific

architectures such as the CRAY and CDC vector supercomputers, the MasPar, the Connection Machine, the ICL DAP, and others.

ECE505 Computer Architecture

This course is an introductory graduate course in computer architecture. Most aspects of CPU architecture are covered using a combined hardware/software approach. Specific topics include datapath design, memory systems, microprogramming, memory management, operating systems, and instruction set design.

ECE579M Real-Time System Design

This course focuses on the design of computer systems for which the timeliness of producing results is a critical factor for establishing the correctness of the system design. Topics covered include hardware specification, real-time operating systems and programming, scheduling, communications, and validation/verification. Issues and choices arising for single processor and distributed systems are also covered. Both hard and soft real-time system issues and the interactions between real applications and real systems is stressed.

ECE2010 Introduction to Electrical and Computer Engineering.

The objective of this course is to introduce students to the broad field of electrical and computer engineering within the context of real world applications. This course is designed for first-year students who are considering ECE as a possible major or for non-ECE students fulfilling an out-of-major degree requirement. The course will introduce basic electrical circuit theory as well as analog and digital signal processing methods currently used to solve a variety of engineering design problems in areas such as entertainment and networking media, robotics, renewable energy and biomedical applications. Laboratory experiments based on these applications are used to reinforce basic concepts and develop laboratory skills, as well as to provide system-level understanding. Circuit and system simulation analysis tools are also introduced and emphasized.

ECE2019 Sensors, Circuits, and Systems.

This course investigates commonly used sensors such as resistive temperature sensors, capacitive touch sensors, and inductive motion sensors and actuators. Numerous applications are presented to motivate coverage of fundamental operating principles of circuit elements such as resistors, capacitors, and inductors; model the signals produced by these sensors; and analyze the circuits and systems used to amplify and process these signals. After a review of Kirchhoff's current and voltage laws, fundamental analysis techniques such as Thevenin and Norton's theorems and the superposition principle are used to model and analyze sensors, circuits, and systems. Concepts from analysis of linear, time-invariant continuous-time signals and systems are introduced as necessary, including Fourier series and characterization of systems such as filters in both the frequency domain (bandwidth, transfer function) and time domain (rise time, step response). Capacitance, inductance and mutual inductance are explored as energy storage elements, including consideration of resonance and energy losses in power systems. Concepts

will be reinforced with the use of laboratory exercises and computer simulation. Recommended background: ECE 2010, MA 1024 (or equivalent), PH 1120/21 and MA 2051 (concurrent) Note: Students who have received credit for ECE 2111 may not receive credit for ECE 2019.

ECE2022 Introduction to Digital Circuits and Computer Engineering.

The objective of this course is to expose students (including first year students) to basic electrical and mathematical concepts that underlie computer engineering while continuing an introduction to basic concepts of circuits and systems in a hands-on environment. Experiments representing practical devices introduce basic electrical engineering concepts and skills which typify the study and practice of electrical and computer engineering. In the laboratory, the students construct, troubleshoot, and test analog and digital circuits that they have designed. They will also be introduced to the nature of the interface between hardware and software in a typical microprocessor based computer.

ECE2801 Foundations of Embedded Systems

This course teaches the principles of programming microprocessors and microcontrollers for real-time applications. Students are introduced to software engineering principles and are taught how to translate product specifications into engineering solutions.

ECE2799 ECE Design

This is a new course added to the curriculum that teaches sophomore Electrical Engineering students the basic principles of design. Topics are covered which range from project planning and management through manufacturing and implementation. Students are exposed to external factors influencing design such as safety, liability, cost, and other constraints.

ECE3801 Logic Circuits

This is an introductory course in logic circuit design. Topics covered include Boolean Logic, Algebraic minimization of logic equations, Karnaugh Maps, sequential machine design and timing analysis.

ECE3803 Introduction to Microprocessor Systems

This is an undergraduate-level first-course in microprocessor design. Topics covered include timing analysis, address decoding, memory system design, assembly language programming, programmed I/O, and digital/analog interfacing. Experiments are run using ISA-bus interfaces to standard PCs.

ECE3810 Advanced Digital System Design

This course addresses the design of advanced digital logic systems using VHDL to design, synthesize and model digital circuits, and to implement these circuits using Xilinx FPGA

devices. The course emphasizes understanding functional design, designing for speed and power objectives, and testing. The course ends with students designing moderately complicated “system on a chip” (SOC) based systems

ECE4815 Computer Architecture (crosslisted as CS4515)

A first course in computer architecture. Essential aspects of CPU architecture are covered using a combined hardware/software approach. Students learn how a CPU interprets and processes instructions. Issues associated with interfacing hardware with software are covered in detail as are the hardware/software tradeoffs associated with performance optimization.

ECE4801 Microprocessor System Design

Microprocessor System Design is the second course in the microprocessor sequence. In this course, students learn the advanced concepts used in modern microprocessor systems. Topics such as system organization, dynamic and cache memory systems, communications, mixed language programming, and device driver design are covered.

ECE430X Fundamentals of Navigation Systems

This course introduces students to the fundamentals of navigation using electronic systems. The course covers types of navigation systems, how to interpret sensor data and sources of navigation system error. Topics include: types of navigation systems (dead reckoning, inertial, radio based systems), sensors and error sources, coordinate frames and transformations, system dynamics and measurement processing. Case studies explore the use of accelerometers, gyroscopes, GPS (including, differential and assisted GPS) as well as other types of navigation systems.

RBE 3001 Unified Robotics III

Third of a four-course sequence introducing foundational theory and practice of robotics engineering from the fields of computer science, electrical engineering and mechanical engineering. The focus of this course is actuator design, embedded computing and complex response processes. Concepts of dynamic response as relates to vibration and motion planning will be presented. The principles of operation and interface methods various actuators will be discussed, including pneumatic, magnetic, piezoelectric, linear, stepper, etc. Complex feedback mechanisms will be implemented using software executing in an embedded system. The necessary concepts for real-time processor programming, re-entrant code and interrupt signaling will be introduced. Laboratory sessions will culminate in the construction of a multi-module robotic system that exemplifies methods introduced during this course.

RBE 3002 Unified Robotics IV

Fourth of a four-course sequence introducing foundational theory and practice of robotics engineering from the fields of computer science, electrical engineering and mechanical engineering. The focus of this course is navigation, position estimation and communications.

Concepts of dead reckoning, landmark updates, inertial sensors, vision and radio location will be explored. Control systems as applied to navigation will be presented. Communication, remote control and remote sensing for mobile robots and tele-robotic systems will be introduced. Wireless communications including wireless networks and typical local and wide area networking protocols will be discussed. Considerations will be discussed regarding operation in difficult environments such as underwater, aerospace, hazardous, etc. Laboratory sessions will be directed towards the solution of an open-ended problem over the course of the entire term.

RBE 400x Robot System Engineering and Design

The designers of robotic systems start with a system requirement to define the mechanical, electrical and software systems which must work together to achieve the system goals. Typically, parallel teams of engineers will work concurrently to create the requirements document as well as model various aspects of the system to verify operational capabilities and the ability to meet time and budget constraints. For complex systems, the development of such teams can itself be a complex problem since the project has to be organized in such a way that parallel teams can work independently, yet have excellent communication channels and information passing to insure project success.

This course explores the tools and techniques used to develop complex systems. The topics covered include: requirements development; system architecture and partitioning; requirements flowdown; functional and interface specifications; trade studies; system modeling and simulation; system integration; as well as design verification and validation.

RBE500 Foundations of Robotics

Foundations and principles of processing sensor information in robotic systems. Topics include an introduction to probabilistic concepts related to sensors, sensor signal processing, multi-sensor control systems and optimal estimation. The material presented will focus on the types of control problems encountered when a robot must operate in an environment where sensor noise and/or tracking errors are significant. Techniques for assessing the stability, controllability and expected accuracy of multi-sensor control and tracking systems will be presented. Lab projects will involve processing live and synthetic data, robot simulation and projects involving the control of robot platforms.

RBE502 Robot Control

This course reviews the interplay between control and robotics through introducing theory and demonstrating applications. It aims to provide an in-depth coverage of control design for robotic manipulators and mobile robots. We focus primarily on fundamental theory, control design methods, and their application on practical robotic systems. Topics may include modeling of robotic systems, linear/nonlinear control of robotic systems, control of under-actuated robotic systems, optimal control, adaptive control, behavior-based robots. Course projects will emphasize modeling, simulation and practical implementation of control systems for robot applications.

RBE594 Capstone Project Experience In Robotics Engineering

This project-based course integrates robotics engineering theory and practice, and provides the opportunity to apply the skills and knowledge acquired in the Robotics Engineering curriculum. The project is normally conducted in teams of two to four students. Students are encouraged to select projects with practical significance to their current and future professional responsibilities. The projects are administered, advised, and evaluated by WPI faculty as part of the learning experience, but students are also encouraged to seek mentorship from experienced colleagues in the Robotics Engineering profession.

3. List of Publications:

3.1 Journal Papers

- [1] DiLuoffo, Vincenzo, and William R. Michalson. "A Survey on Trust Metrics for Autonomous Robotic Systems." arXiv preprint arXiv:2106.15015 (2021).
- [2] V. Diluoffo, W. R. Michalson and B. Sunar, "Robot Operating System 2: The need for a holistic security approach to robotic architectures," *International Journal of Advanced Robotic Systems*, 15.3, 2018.
- [3] T. Padir, W.R. Michalson, et. al., "Implementation of an Undergraduate Robotics Engineering Curriculum," *Computers in Education Journal*, vol. I, no. 3, pp. 92-101, 2010.
- [4] W. R. Michalson, A. Navalekar and H. Parikh, "Error mechanisms in indoor positioning systems without support from GNSS," *The Journal of Navigation*, Cambridge University Press, vol. 62, no. 2, pp. 239-49, 2009.
- [5] H.K. Parikh and W. R. Michalson, "Impulse Radio - UWB or Multicarrier UWB for Non-GPS based Indoor Precise Positioning Systems," *NAVIGATION J. Inst. Nav.*, Vol. 55, no. 1, 2008.
- [6] I. F. Progri, W. R. Michalson, J. Wang and M.C. Bromberg, "Indoor Geolocation Using FCDMA Pseudolites: Signal Structure and Performance Analysis", *NAVIGATION J. Inst. Nav.*, Vol. 54, No. 3, Fall 2007.
- [7] I. F. Progri, M. C. Bromberg and W. R. Michalson, "Maximum-Likelihood GPS Parameter Estimation", *NAVIGATION J. Inst. Nav.*, vol. 52, no. 4, pp. 229-238, Winter, 2005-2006.
- [8] I.F. Progri, W.R. Michalson, and D. Cyganski, "An OFDM/FDMA Indoor Geolocation System," *NAVIGATION J. Inst. Nav.*, vol. 51, no. 2, pp. 133-142, Summer, 2004.
- [9] I.F. Progri, G. Bogdanov, V.C. Ramanna, and W.R. Michalson, "An Investigation Of A GPS Adaptive Temporal Selective Attenuator," *NAVIGATION J. Inst. Nav.*, Vol. 49 No. 3, pp. 137-147, 2002.
- [10] G. Bogdanov, W. R. Michalson, and R. Ludwig, "A new apparatus for non-destructive evaluation of green-state powder metal compacts using the electrical resistivity method," *Measurement Science and Technology*, IOP Publishing, vol. 11, pp. 157-166, January 2000.

- [11] B. Findlen, E. Reuter, R. Campbell, and W. R. Michalson, "Effects of time domain response on the sonic characteristics of microphones," *Journal of the Acoustical Society of America*, vol. 104, no. 3, pt. 2 pp. 1764, September 1998.
- [12] J. Sedgwick, W. R. Michalson, and R. Ludwig, "Design of a Digital Gauss Meter for Precision Magnetic Field Measurements," *IEEE Transactions on Instrumentation and Measurement*, vol. 47, no. 4, pp. 972-977, August 1998.
- [13] J. Stander, J Plunkett, W. Michalson, J. McNeill, and R. Ludwig, "A Novel Multi-Probe Resistivity Approach to Inspect Green-State Powdered Metallurgy Compacts," *Journal of Non-Destructive Evaluation*, vol. 16, no. 4, pp. 205-214, 1997.
- [14] Woltereck, R. Ludwig, and W. Michalson, "A Quantitative Analysis of the Separation of Aluminum Cans Out of a Waste Stream Based on Eddy Current Induced Levitation," *IEEE Transactions on Magnetics*, vol. 33, no. 1, pp. 772-781, January 1997.
- [15] W. R. Michalson, "Auralization on a Laptop PC," abstract appears in *The Journal of the Acoustical Society of America* , vol. 100 No. 4, Pt 2, pp. 2608, October 1996.
- [16] R. H. Campbell, S. K. Martin, I. Schneider, and W. R. Michalson, "Analysis of Mosquito Wingbeat Sound," *The Journal of the Acoustical Society of America* vol. 100 No. 4, Pt 2, pp. 2710, October 1996.
- [17] W. R. Michalson, "Ensuring GPS Navigation Integrity using Receiver Autonomous Integrity Monitoring," *IEEE Aerospace and Electronic Systems Magazine*. vol. 10, no. 10, pp. 31-34, October 1995.
- [18] S. Clayton, R. J. Duckworth, W. Michalson, A. Wilson, "Determining Update Latency Bounds in Galactica Net," *Concurrency: Practice, and Experience*, vol. 7, no. 7, pp. 595-611, October 1994.

3.2 Conference Papers

- [1] E. Skorina, R. Rameshwar, S. Pirasmepulkul, T. Khuu, A. Caracappa, P. Luxsuwong, M. Luo, W. R. Michalson, and C. Onal, "Soft Robotic Glove System for Wearable Haptic Teleoperation," WM Symposium 2018, March 18 - 22, 2018 - Phoenix Convention Center.
- [2] K.C. Seals, W.R. Michalson, R.J. Hartnett and P.F. Swaszek, "Using Both GPS L1 C/A and L1C: Strategies to Improve Acquisition Sensitivity," Proc. 26th International Technical Meeting of the Satellite Division of the Institute of Navigation (ION GNSS 2013), Sep. 16-20, 2013.
- [3] K.C. Seals, W.R. Michalson, R.J. Hartnett and P.F. Swaszek, "Semi-Coherent and Differentially Coherent Integration for L1C Acquisition," Proc. 2013 International Technical Meeting of the Institute of Navigation (ION ITM 2013), Honolulu, HI, Apr. 22-25, 2013.
- [4] J.M. Barrett, M.G. Gennert, W. R. Michalson, et. al., "Development of a Low-Cost, Self-Contained, Combined Vision and Inertial Navigation System," 2013 International Conference on Technologies for Practical Robotic Applications, Boston, MA Apr. 22-23, 2012.

- [5] K.C. Seals, W.R. Michalson, R.J. Hartnett and P.F. Swaszek, "Analysis of L1C Acquisition by Combining Pilot and Data Components Over Multiple Code Periods," Proc. 2013 International Technical Meeting of the Institute of Navigation (ION ITM 2013), San Diego, CA, Jan. 28-30, 2013.
- [6] K.C. Seals, W.R. Michalson, R.J. Hartnett and P.F. Swaszek, "Analysis of Coherent Combining for L1C Acquisition," Proc. 25th International Technical Meeting of the Satellite Division of the Institute of Navigation (ION GNSS 2012), pp.384-393, Nashville, TN, Sep. 17-21, 2012.
- [7] J.M. Barrett, M.G. Gennert, W. R. Michalson and J.L. Center, "Analyzing and Modeling an IMU for Use in a Low-Cost Combined Vision and Inertial Navigation System," 2012 International Conference on Technologies for Practical Robotic Applications, Boston, MA Apr. 23-24, 2012.
- [8] G. Fischer, W. R. Michalson, T. Padir and G. Pollice,"Development of a Laboratory Kit for Robotics Engineering Education" AAAI 2010 Spring Symposium on Educational Robotics and Beyond: Design and Evaluation, Mar. 22-24, Palo Alto, CA, 2010.
- [9] W.R. Michalson, and F. J. Looft, "Designing Robotic Systems: Preparation for an Interdisciplinary Capstone Experience," American Society of Engineering Educators 2010 Annual Conference, Louisville, KY, Jun 20-23, 2010.
- [10] W.R. Michalson, S.J. Bitar and R.C.Labonte, "The Technical, Process, and Business Considerations For Engineering Design – A 10 Year Retrospective," American Society of Engineering Educators 2010 Annual Conference, Louisville, KY, Jun 20-23, 2010.
- [11] M. Gennert, M. Demetrio and W. R. Michalson, "A Robotics Engineering M.S. Degree," American Society of Engineering Educators 2010 Annual Conference, Louisville, KY, Jun 20-23, 2010.
- [12] R. Beach, W. R. Michalson, et. al., "Robotics Innovations Competition and Conference (RICC): Building Community Between Academia and Industry Through a University-Level Student Competition," American Society of Engineering Educators 2010 Annual Conference, Louisville, KY, Jun 20-23, 2010.
- [13] G. Tryggvason, W.R. Michalson, et. al., Teaching Multidisciplinary Design to Engineering Students: Robotics Capstone," American Society of Engineering Educators 2010 Annual Conference, Louisville, KY, Jun 20-23, 2010.
- [14] A.C.Navalekar, W.R. Michalson, "Asymmetric throughput problem due to Push-to-talk (PTT) delays in CSMA/CA based heterogeneous Land Mobile Radio (LMR) networks", accepted for publication, Milcom 2009.
- [15] A. Navalekar and W.R. Michalson, "Effects of Unintentional Denial of Service (DOS) due to PTT delays on performance of CSMA/CA based Adhoc Land Mobile Radio (LMR) networks", accepted for publication, ICST Adhocnet 2009.
- [16] W. R. Michalson, et. al., "Unified Robotics: Balancing Breadth and Depth in Engineering Education", American Society of Engineering Educators 2009 Annual Conference, AC 2009-1681, Austin, TX, Jun 14-17, 2009.

- [17] G. Tryggvason, W.R. Michalson, et. al., "Robotics Engineering: A New Discipline for a New Century", American Society of Engineering Educators 2009 Annual Conference, AC 2009-997, Austin, TX, Jun 14-17, 2009.
- [18] M. DiBlasi, W. R. Michalson, et. al., "Social Networking in the FIRST Robotics Competition Community," ASEE Northeast Section Conference, University of Bridgeport, Apr 3-4, Bridgeport, CT, 2009.
- [19] A. Navalekar, H.K Parikh and William R. Michalson, "Error Mechanisms in Indoor Positioning Systems without Support from GNSS", RIN NAV 08.
- [20] A. Navelekar, W.R. Michalson, et. al., "Effects of Push-To-Talk (PTT) delays on Throughput Performance of CSMA/CA based Distributed Digital Radios (DDR) for Land Mobile Radio (LMR) Networks," 37th International Conference on Parallel Processing (ICPP-08), Portland, OR, Sep. 8-12, 2008.
- [21] M. Ciraldi, W. Michalson, et. al., "The New Robotics Engineering BS Program at WPI," American Society of Engineering Educators 2008 Annual Conference, AC 2008-1048, Pittsburgh, PA, Jun 22-25, 2008.
- [22] A.C.Navalekar, W.R. Michalson, "A New Approach to Improve BER Performance of a High Peak-to-Average Ratio (PAR) OFDM signal over FM based Land Mobile Radios (LMR)", IEEE WTS 08, Pomona, CA.
- [23] A. Navelekar and W.R. Michalson, "Effects of Push-To-Talk (PTT) delays on CSMA based Capacity Limited Land Mobile Radio (LMR) Networks," *Proc. IEEE Intl. Symp. Wireless Pervasive Computing 2008 (ISWPC08)*, Santorini, Greece, May 7-9, 2008.
- [24] H.K. Parikh and W.R. Michalson, "Error Mechanisms In An Rf-Based Indoor Positioning System," *Proc. 2008 IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP '08)*, Las Vegas, NV Mar 30 – Apr 4, 2008.
- [25] B. Woodacre, W. Michalson, et. al., "WPI Precision Personnel Locator System - Automatic Antenna Geometry Estimation," to appear, *Proc. ION-NTM 2008*, San Diego, CA, Jan 27-29, 2008.
- [26] H.K. Parikh, A. Navelekar and W.R. Michalson, "Issues in Achieving Precise Positioning Indoors Without Support from GNSS," *Proc. ION-NTM 2008*, San Diego, CA, Jan 27-29, 2008.
- [27] D. Cyganski, W. Michalson, et. al., "WPI Precision Personnel Locator System - Evaluation by First Responders," *Proc. Institute of Navigation GNSS 2007*, Fort Worth, TX, September 25-28, 2007.
- [28] I.F. Progri, W. R. Michalson, et. al., "Maximum Likelihood OFDMA Parameter Estimation," *Proc. Institute of Navigation GNSS 2007*, Fort Worth, TX, September 25-28, 2007.
- [29] C.W. Kelley, W. R. Michalson, et. al., "Discrete vs. Continuous Carrier Tracking Loop Theory, Implementation, and Testing with Large BnT," *Proc. Institute of Navigation GNSS 2007*, Fort Worth, TX, September 25-28, 2007.

- [30] W. R. Michalson and J. W. Matthews, "Distributed Digital Radios and WLAN Interoperability," 2007 IEEE Conference on Technologies for Homeland Security, May 16-17, Woburn, MA, 2007.
- [31] I.F. Progri, W.R. Michalson, J. Wang, M.C. Bromberg, and R.J. Duckworth, "Requirements of a C-CDMA Pseudolite Indoor Geolocation System," *Proc. ION-AM 2007*, Cambridge, MA, pp. 654-658, Apr. 2007.
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- [35] I. F. Progri, J. Maynard, W.R. Michalson, and J. Wang, "The Performance and Simulation of a C-CDMA Pseudolite Indoor Geolocation System," *Proc. Institute of Navigation GNSS 2006*, Fort Worth, TX, September 26-29, 2006.
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- [37] J.W. Coyne, R. J. Duckworth, W. R. Michalson and H.K. Parikh, "2-D Radio Navigation System Using MC-UWB," *Proc. NAV 2005 – Pushing the boundaries*, Royal Institute of Navigation, London, Nov 1-3, 2005.
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- [40] H.K. Parikh and W.R. Michalson, "Performance Evaluation of the Receiver RF Front-End of a Precision Positioning System," *Proc. Institute of Navigation GNSS 2004*, Long Beach Convention Center, Long Beach, CA, September 21-24, 2004.
- [41] W.R. Michalson and H. Ahlehagh, "A 3D Location Discovery Algorithm for Ad Hoc Networks," *ICWN-04, 2004 International Conference on Wireless Networks*, Las Vegas, pp. 567-572, Jun 21-24, 2004.
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3.3 Book Chapters

- [1] W. Michalson and E. Schnieder, "An Approach for Implementing a Reconfigurable Optical Interconnection Network for Massively Parallel Computers," in *Optical Interconnection - Foundations and Approaches*, C. Tocci and H. J. Caulfield Eds., Artech House, proposed release January 1994.

3.4 Patents

Assurance Model for an Autonomous Robotic System feedback user interface

United States Patent Application, October, 2023

Haptic glove as a wearable force feedback user interface

United States Patent 10,551,923, Issued February 4, 2020

A toroidal actuator is responsive to a teleoperator for providing haptic feedback responsive to a curvature or articulated movement applied to a gripped object. The toroidal actuator surrounds an operator member such as a finger, and is responsive to pneumatic pressure for increasing telepresence force defined by resistance encounter against a teleoperated robotic claw. As the teleoperated claw grips an object, increased pneumatic pressure in the toroidal actuator tends to elongate the toroidal shape in a linear manner and oppose a curvature force applied by an inserted operator finger. Resistive force is based on soft sensing of the gripped object, thus the toroidal actuator applies an increasing resistive force to curvature as the robotic claw closes around a gripped object by solenoid regulated air pressure.

Precision location methods and systems

United States Patent 8,928,459, Issued January 6, 2015

The invention describes systems and methods for determining the location of a transmitter by jointly and collectively processing the full sampled signal data from a plurality of receivers to form a single solution.

Tracking device and remote monitoring system

United States Patent Application US20140274115A1

A system includes a remote monitoring device configured to detect and measure one or more signals and to convey detected and measured signal information to a central location. The central

location is configured to determine the location of the remote monitoring device based on the received signal information and is also configured to determine at least one hypothetical path of the remote monitoring device. Abandoned.

Apparatus and methods for addressable communication using voice-grade radios

United States Patent 8,284,711, Issued 9 October 2012

The invention relates to methods and apparatus for conducting directed communication using voice-grade radios. The methods and apparatus can be used to form a packet-switched wireless network using legacy analog transceivers, providing, e.g., both data and voice-over-Internet Protocol communication.

Multi-channel electrophysiologic signal data acquisition system on an integrated circuit.

United States Patent 7,896,807, issued 3 March 2011.

A physiologic data acquisition system includes an analog input, a sigma-delta front end signal conditioning circuit adapted to subtract out DC and low frequency interfering signals from and amplify the analog input before analog to digital conversion. The system can be programmed to acquire a selected physiologic signal, e.g., a physiologic signal characteristic of or originating from a particular biological tissue. The physiologic data acquisition system may include a network interface modulating a plurality of subcarriers with respective portions of an acquired physiologic signal. A receiver coupled to the network interface can receive physiologic data from, and send control signals and provide power to the physiologic data acquisition system over a single pair of wires. The network interface can modulate an RF carrier with the plurality of modulated subcarriers and transmit the resulting signal to the receiver across a wireless network. An integrated circuit may include the physiologic data acquisition system. Also included are methods for acquiring physiologic data comprising the step of selectively controlling an acquisition circuit to acquire the physiologic signal.

Methods and apparatus for high resolution positioning. United States Patent 7,292,189. The invention relates to a method of signal analysis that determines the location of a transmitter and to devices that implement the method. The method includes receiving by at least three receivers, from a transmitter, a first continuous-time signal having a first channel. The first channel includes a first plurality of signal carriers having known relative initial phases and having known frequencies which are periodically spaced and which are orthogonal to one another within a first frequency range. The signal analysis method also includes determining the phase shifts of the carriers of the first channel resulting from the distance the carriers traveled in reaching the first receiver. Analysis of the phase shifts yields time difference of arrival information amongst the receivers, which is further processed to determine the location of the transmitter. 6 Nov 2007.

A Reconfigurable Indoor Geolocation System, US Patent Number 7,079,025. A portable reconfigurable geolocation system is provided. The system includes a portable user node and one or more portable pseudolite nodes in communication one another and with the user node. Each of the user nodes and pseudolite nodes includes a transmitter that generates a signal on one or more carrier frequencies. Each signal is modulated with digital signals necessary to establish distances between the nodes and to convey data between the nodes. Each node also includes a receiver for receiving and demodulating the signals transmitted between the nodes, and a processor for receiving the demodulated signals, extracting data values and derived values from the

demodulated signals and determining a three-dimensional position of each node in the system. Issued 18 Jul 2006.

Auto-Calibrating Surround System, United States Patent 7,158,643. A multi-channel surround sound system and method is described that allows automatic and independent calibration and adjustment of the frequency, amplitude and time response of each channel of the surround sound system. The disclosed auto-calibrating surround sound (ACSS) system includes a processor that generates a test signal represented by a temporal maximum length sequence (MLS) and supplies the test signal as part of an electric input signal to a loudspeaker. A microphone coupled to the processor receives the signal in a listening environment. The processor correlates the received sound signal with the test signal in the time domain and determines from the correlated signals a whitened response of the audio channel in the listening environment. Issued 2 Jan 2007.

Hand-held GPS-mapping device, US. Patent Number 5,987,380. A hand-held navigation, mapping and positioning device contains a GPS receiver, a database capable of storing vector or bit mapped graphics, a viewing port, an embedded processor, a simplified user interface, a data compression algorithm, and other supporting electronics. The viewport is configured such that the data presented in the viewport is clearly visible in any ambient light condition. The database stores compressed image data which might include topographical map data, user annotations, building plans, or any other image. The system includes an interface to a personal computer which may be used to annotate or edit graphic information externally to the device for later upload. In addition, the device contains a simple menu-driven user interface which allows panning and zooming the image data, marking locations of interest, and other such functions. The device may be operated from an internal rechargeable battery, or powered externally. Issued 16 Nov 1999.

Hand-held GPS-mapping device, US. Patent Number 5,902,347. A hand-held navigation, mapping and positioning device contains a GPS receiver, a database capable of storing vector or bit mapped graphics, a viewing port, an embedded processor, a simplified user interface, a data compression algorithm, and other supporting electronics. The viewpoint is configured such that the data presented in the viewport is clearly visible in any ambient light condition. The database stores compressed image data which might include topographical map data, user annotations, building plans, or any other image. The system includes an interface to a personal computer which may be used to annotate or edit graphic information externally to the device for later upload. In addition, the device contains a simple menu-driven user interface which allows panning and zooming the image data, marking locations of interest, and other such functions. The device may be operated from an internal rechargeable battery, or powered externally. Issued 11 May 1999.

3.5 Professional Presentations

American Ambulance Association Annual Meeting: Low-cost VHF/UHF Interoperability for digital telemetry, Las Vegas, NV, Dec. 2005.

California Ambulance Association, Keynote address: Alternatives to solving interoperability problems in Land Mobile Radios, Lake Tahoe, NV, July 2005.

Museum of Science Lecture Series: The Next Generation of Information and Communications Technologies-What does the Future Hold?, William R. Michalson and Brian King, January 14, 2004.

Agilent Wireless Technology Summit: Dynamic Node Location in an Ad Hoc Indoor Communications and Positioning Network, William R. Michalson, January 27, 2004

Security & Technology Online (SATO) Security Leadership Council. Panel discussion on Smart Surveillance, Command and Control, Oct 28-29, 2004.

“Worcester Polytechnic Institute Barcelona Summit: The Future of Information Technology,” delivered presentation entitled “Personal Navigation in the Information Age,” Apr 2001.

4. Projects advised (undergraduate).

4.1 Major Qualifying Projects (current)

- [1] *Formula SAE Electric*, S. V. Boyd, T.A., T.A. Ninesling, E.R. Robert, J.M. Duffield, B.P. Steeves, J.B. Chase, N.S. Bajakian, N.R. Alescio, R.D. Johnson, C.L. Besch, T.R. Schaeffer, MQP-DCP-AB82/MQP-WZM-EV21, 2021.
- [2] *SailBot 2021*, C.J. Burri, M.J. Laks, L.C. Zebrowski, N.H. Jackson, C.J. Scholler, N.J. Eusman, A.V. Thammana, MQP-WZM-SB21, 2021.
- [3] *Ship Recycling Robot*, N.M. Kalsih, S.I. Morales, J. Cybul, J.D. Hoy, T.H. Reiser, MQP-BC2-SRR1, 2021.
- [4] *Tethered Submersible Surveyor*, B.L. Ward, L.C. Reid, J.A. Conklin, J.Y. Huang, MQP-YGB-SUB2/MQP-WZM-SUB1, 2021.
- [5] *Underwater Communications*, L. Spalding, MQP-WZM, 2021.
- [6] *Lionfish IIII*, MQP-CBP, 2021.

4.2 Major Qualifying Projects (completed)

- [7] **Remote Water Monitoring*, Daniel Shrives, T. Vose, and B. Rolfes, MQP-WZM-AB0R, 2020. [* Winner – Provost’s MQP Award in Robotics Engineering]
- [8] *SailBot 2019-2020 MQP*, I. Lavryonova, T. Andrews, M. Guzman, and K. Reese, MQP-WZM-ABWT, 2020.
- [9] *Firefighting Remote Exploration Device II*, J. Cheng, D. Karavoussianis, A. Moseley, and L. Sahyun, CP4-MQP-FIRE, co-advised, 2020.
- [10] *Mohamed Bin Zayed International Robotics Challenge at Takemura Lab, Osaka University*, N. Greig and D. McHorney, WZM-MQP-ABVE, 2020

- [11] *Lionfish Harvesting Robot – Phase III*, M. Abadjiev, Q. Chen, C. Ewen, N. Johnson, N. Olgado, H. Saperstein, O. Strickland, and C. Whimpenny, WZM-MQP-ABVF, 2020.
- [12] *Underwater 3D Data Collection*, D. Pelaez, T. LaCroce, and N. Budris, WZM-MQP-ABVK, 2020.
- [13] *Efficient Multi Robot Mapping: Quick and Sustained Environmental Surveying with Limited Communication*, D. Abraham, T. Bergeron, and C. Dembski, WZM-MQP-AB0P
- [14] *Leveraging NVMe Management Interface to Provide SES Support for Enterprise Server Diagnostics*. T. P. Mackintosh, WZM-MQP-ABQ3, 2019.
- [15] *Sailbot 2018-19*. S. T. Palmer, K.B. Randall and S. A. Fisher, MQP-KZS-SBOT/MQP-WZM-SAIL, 2019.
- [16] *Firefighting Remote Exploration Device*, E. M. Barinelli, J. L. Berman-Jolton, G. K. MacNeal, K. R. Naras, M. Tasellari, and Y. A. Verdeja. MQP-CP4-ABQE, 2019.
- [17] *Vertical Take-Off and Landing Autonomous Aircraft Design*, Q. C. Barker, T. P. Bergeron, J. A. Goldsberry, J. Romelle, B. H. Pasculano, B. M. Waterman, T. M. Weiss, and Z. J. Zolotarevsky, MQP-RVC-1901, 2019.
- [18] *Mobile Manipulation Testbed*, N. S. Dennler, M. LeMay, and T. J. Macaluso, MQP-WZM-AD19, 2019.
- [19] *K.O.L.T.: Known Object Localization and Mapping*, N. A. Rosenberg, MQP-WZM-DRMP, 2019.
- [20] *Walking Quadrupedal Platform*, N. C. Franco, N. M. Liedtke, and D. Lu, MQP-WZM-QUAD, 2019.
- [21] *Wolfgang: An Autonomous Mobile Robot for Outdoor Navigation*, A. U. Cookson, M.E. Landergan, and S. T. O’Neil, MQP-XIH-AD19, 2019.
- [22] *MGH Biomedical Imaging Tools*, I. Alexiou, MQP-SNM-SNMA, 2019. *Automated Sandwich Assembly*, Derek W. Feehrer, Carter C. Reynolds, Jaime R. Stephen, Taylor A. Stephen, MQP WZM 17A1, 2018.
- [23] *Localization for FRC*, Hu, J., Mitrano, P., Puczydlowski, K. and Vere, N., 2017.
- [24] **Sailbot 2017-2018 Final Report*, Burklund, J., Johnson, H., Norris, T. and Shanahan, L. 2018. [* Winner – Provost’s MQP Award in Robotics Engineering, Winner – Professional Writing Award].
- [25] *QRP – Quadrupedal Robotics Platform*, Armsby, Z., Cole, R., Coll, B., Martin, J., and Nagal, A., 2018.
- [26] *Embedded GPU-Based Image & Signal Processing Prototype*, Baker, L and Song, D. Lincoln Laboratories, 2018.
- [27] *Music and Wearable Technology*, Perry, L.M., Ferguson, E.E., Barreiro, M.P., 2017.
- [28] *Collaborative Robotics Heads-Up Display*, Christopher Bove and Alexander Wald, MQP-WZM-16A1, Lincoln Laboratories, 2017.
- [29] *Low Cost Quadrupeds*, Joshua Graff, Kevin Maynard, and Alonzo Martinz, MQP-WZM-16A2, 2017.

- [30] *Fire Response Drone*, John Lomi, Zachary Hood, Kyle Young, Chase St. Laurent, and William Boyd, MQP-WZM-16A3, 2017.
- [31] *Smart Transradial Prosthesis*, Yesugey Sipka, ID-CDO-1603, 2017
- [32] **Sailbot 2016*, Nicholas Gigliotti, James Kuszmaul, Tucker Martin, and Ryan Wall, 2016. [* nominated for the Provost's MQP Award in Computer Science].
- [33] *Autonomous Snowblower*, Nicholas Rowles, Daniel Pongratz, Harrison Vaporciyan, , 2017.
- [34] **Body Armor Impact Map System*, Carolyn S. Keyes, ME; Nicholas B. Potvin, ECE; and Zachary R. Richards, CS, MQP-WZM-15A1, 2016. [* winner of the Mechanical Engineering Department's MQP Award].
- [35] *Highway Safety Merge System*, Dante A. Pace, ECE; and Sunghoon Yoon, CS, MQP-MYE-AAS5, 2016.
- [36] *Highway Safety Merge System*, Christopher M. Ellen, RBE; MQP-MYE-AATK, 2016.
- [37] *Collaborative Robotics Heads-Up Display*, Bove, C.P. and Wald, A., WPI Lincoln Laboratories Project Center, 2016.
- [38] *De-Mining with UAVs*, Gregory G Tighe
- [39] *Arc-Liberation of Intermolecular Bond Energy for Marine Propulsion*, Rohan Jhunjunwala, ME; James Deane Jackman, CS; Tyler Jon Ewing, ME; Christopher Michael Byrne, ECE; Christopher William Egan, ECE, 2015.
- [40] *Glovesense Data Glove*, Nathan William Joseph Wiegman, ECE,; Nathan Harrison Wells, ECE; Russell Hagan Hedlund, ECE,; and Mert Can Erad, ECE, 2015.
- [41] *Mobile Motion Capture*, Robert Patrick Dabrowski, ID; and Matthew Stephen Costi, ID, 2014.
- [42] *Intelligent LED Display*, Harrison Chabot Williams, ECE; Rayce Coleman Stipanovich, ECE; and Alexander Joseph Ryan, ECE, 2014.
- [43] **Design and Optimization of a FSAE Vehicle*, Justin Shane Paprota, ECE; and Camden Ryan Mallette, ECE, 2014. [* winner of the Provost's MQP Award in Mechanical Engineering].
- [44] *Sailboat Stabilization System*, Steven Mize Rutledge, ECE; Pedro John Miguel, ECE; Dominic Student author Gonzalez, ECE; and Michael Eric Brendlinger, RBE, 2014.
- [45] *Real Time Person Tracking and Identification using the Kinect sensor*, Nikolaos Matthiopoulos and Matthew Francis Fitzpatrick, 2013.
- [46] *H.E.A.T. – Home Energy Automation Technology*, John Thomas Manero, ECE; Scott James Cloutier, ECE; Michael Dominick Audi, ECE-RBE, 2012.
- [47] *Automated Refueling for Hovering Robots*, Raymond P. Short, RBE; Janine S. Pizzimenti, RBE; and Nigel Bowers Cochran, RBE, 2012.
- [48] *Improved Intelligence and Systems Integration for WPI's UGV – Prometheus*, Gregory Duncan McConnell, RBE; Samson Michael King, RBE; Craig Alan DeMello, RBE; Michael A. Rodriguez, RBE; and Eric J. Fitting, ID, 2012.

- [49] *Aeacus – development of a bio-inspired robotic platform for swarm-based multi-object transport over uneven terrain*, N. Anderson, D. Praetorius and C. Roddy, co-advised with S. Nestinger, 2011.
- [50] *Realization of Performance Advancements for WPI's UGV-Prometheus*, M. Akmanalp, R. Doherty, J. Gorges, P. Kalasuskas, E. Peterson and F. Polido, co-advised with T. Padir, S. Nestinger, M. Ciraldi, K. Stafford, 2011.
- [51] *Optimization of an Autonomous Underwater Vehicle*, J. Baker, C. Frumento, J. Grzyb and T. North, co-advised w/I. Hussein, 2011.
- [14] *Intelligent Tactical Vest*, V. Brisian, J. Fernando, A. Khandaker and J. Zorrilla DeLos Santos, 2011.
- [15] *Quadrotor UAV Interface and Localization Design*, N. Smith, B. Berard and C. Pietre, Lincoln Laboratory Project Center, co-advised with G. Heineman, 2011.
- [16] *Voice Release System*, J. Low, WZM-MQP-1M10, 2010.
- [17] *Design and Realization of an Intelligent Unmanned Ground Vehicle*, J. Barrett, B. Roy and D. Sacco, Co-Advised w/T. Padir, 2010.
- [18] *Real-time Digital Modeling of analog circuitry for audio applications*, B. Gleason, WZM-MB09, 2010.
- [19] *Optimization and Control Design of an Autonomous Underwater Vehicle*, D. Moussette, A. Palooparambil, and J. Raymond, AE- IHH-0003, co-advised w/I. Hussein, 2010.
- [20] *Design of Autonomous Underwater Vehicle and Optimization of Hydrodynamic Properties and Control*, R. David, WZM-3A08, 2009.
- [21] *Autonomous Vehicle Control*, Breznak, R. S., Cunningham, A. G and Kleinfeld, Z., 2008.
- [22] *Roof Robot Phase 2*, Zachary James Strowe, ECE; and Xu Lin, ECE, 2008.
- [23] *The Thumper Robotic Bass*, B. Kosherick, M. Brown, and A. Teti, WZM-RB08, 2008.
- [24] *Public Safety Integration Center*, P. Lucia, I. Levin and M. Barone, WZM-1A08, 2008.
- [25] *Aircraft Lasercom Terminal Compact Optical Module*, B. Scoville and S. Rose, Lincoln Laboratory Project Center, WZM-2A08, 2008.
- [26] *PANSAT Triple Modular Redundant (TMR) Satellite Flight Computer v3*, Kevin Zhang, ECE; and Karim G. Makram, ECE, 2006.
- [27] *GPS Attitude Determination System*, J.P. Salmon, Michael LaBossiere and Mark Minotaur, 2005.
- [28] *FPGA Implementation of an OFDM Modem*, Andrew Dupont and Jack Coyne, 2005.
- [29] *TREMOR – A Triple Modular Redundant Flight Computer for WPI's PANSAT – Revision 2*, Maulin Patel, Omar Moussa and Matthew Kwiatkowski, 2005.
- [30] *Construction of a GPS Pseudolite*, Tim Coffey, 2005.
- [31] *Dipole Antenna Placement in a Falcon-20 Aircraft*, Emily Anesta and David Plourde, Lincoln Laboratories Project Center, A-Term, 2004.

- [32] *GPS Attitude Determination System*, Joshua Holwell, Himanshu Agrawal and Andrew Coonradt, 2004.
- [33] *TMR Computer System*, Ryan Angilly, Mitch Lauer and Dan Debiasio, 2004.
- [34] *Personal Inertial Navigation System*, Jason DeChiaro and Christopher Strus, 2003.
- [35] WZM-MQP-4A02: *PC I/O in High Stress Environments*, John Niesz and James Kent, 2003.
- [36] WZM-MQP-2A02: *Vacuum Tube Amplifier*, Joseph Kambourakis and Gregory Molnar, 2003.
- [37] *Container Tracking System*, Victoria Chaplick, 2003.
- [38] WZM-MQP-2A03: *Heat Management System for PCs*, Ernest Cardin, Kevin Candiloro and Stephen Leavey, 2002.
- [39] WZM-MQP-1313: *Digital Image Enhancement*, Julie Bolduc, Joeseeph Perry, Wei Fu, 2002.
- [40] WZM-MQP-2A01: *Synchronized Audio Sample Looper*, Joel Gottshalk, Robert Conrad and Sanford Freedman, 2002.
- [41] WZM-MQP-1A01: *Springboard Digital Multimeter*, Pavel Loven and Andrew Young, 2002.
- [42] *Ballistic Missile Defense Analysis Toolkit*, Winfield Peterson, Doug Tilkin and Benjamin Wilson, Lincoln Laboratories Project Center, 2002.
- [43] HU-FB-CS01, *C Sound Synthesizer*, Peter W. DeBonte (co-advised).
- [44] WZM-MQP-1A00: *StrongArm-Based Computer System*, Bradford Snow, 2001.
- [45] WZM-MQP-1C01: *PC Controlled Laser Light Show Device*, Joel Smith, 2001.
- [46] WZM-MQP-1E00: *PIC-based MIDI Sequencer* Malcolm Beaulieu, 2001.
- [47] WZM-MQP-2A00: *Automotive PC Development Platform* Travis Pouliot and David Philips, 2001.
- [48] *The RoadCom Automotive Computing System*, Benjamin Kennedy and John Pong, 2000.
- [49] WZM-MQP-1A99: *Compressed Sample Wavetable Synthesizer*, Justin Brzozoski, 2000.
- [50] WZM-MQP-3499, *Automatically Equalizing Monitor*, Fernando Braghin, Tenzin Lama, Rahul Bhan and Dion Soetadi, 2000.
- [51] 99D163M: *Railroad Communication*, Benjamin Richards, 2000.
- [52] CS-MXC-IE00: *PIC Real-Time Sequencer*, Alexander Goodrich, 2000.
- [53] 99D514M: *Design of a Microphone Preamplifier*, Eric Reuter, 2000.
- [54] WZM-MQP-1A99, *MPEG Audio Deck*, Justin Brzozoski, 2000.
- [55] *Digital Image Enhancement*, Julie Bolduc, Wei Fu and Joseph Perry, 2000.
- [56] WZM-MQP-4A98, *Railroad Communications System*, Matthew Lug, 1999.
- [57] 99D078M: *Modular Effects Processor II*, Erik Neyland, 1999.

- [58] 99D176M: *Portable Digital Audio Recorder* Eric Toledo and Duc Truong, 1999.
- [59] EE-WZM-1A97, *C Sound Synthesizer*, Ross E. Borgeson, Michael W. Hamel and Matthew S. Walsh, 1998.
- [60] EE-WZM-4A97, *Firewire Audio Device*, Daniel R. Stutzbach, 1998.
- [61] EE-WZM-2A97, *Modular Effects Processor*, Michael J. Dellisanti, 1998.
- [62] EE-WZM-3A97, *GPS Personal Navigation*, Jeffery A. Alderson and Helder Machado, 1998.
- [63] HU-FB-CS01, *C Sound Synthesizer*, Peter W. DeBonte (co-advised).
- [64] EE-WZM-1E97, *PM Measurement System*, Yevgeniy Bogdanov.
- [65] EE-REL-C008, *Design and Development of a Microprocessor-Based Gaussmeter*, David M. Burnham.
- [66] EE-WZM-RC01, *Acoustic Guitar Amplifier*, Christopher Thomas.
- [67] EE-WZM-GSD1, *Guitar Sustaining Device*, Paul D'Ambra.
- [68] EE-RXV-5260, *Audio Feedback Elimination System*, Ross D. Pease and John R. Pelliccio.
- [69] EE-RJD-M963, *Embedded Systems Design*, Christopher A. Briggs and Anthony J. Viapiano.
- [70] EE-WHE-9601, *GPS Hazard Detector*, Michael Roberts, William Cidela, and Chris Mangiarelli.
- [71] EE-WZM-2C96, *Flexible Synthesis*, Noah T. Vawter and Luke Demoracski.
- [72] EE-WZM-1A96, *Tap Dancer MIDI Interface*, Thomas Trela and William Dowell.
- [73] EE-WZM-2A96, *GPS Hazard Detector II*, Will Brothers, Jon Day, and John Zaghi.
- [74] EE-WZM-3A96, *Loudspeaker Data Acquisition System*, Adam Gross.
- [75] EE-WZM-4A96, *Audio Morphing Processor*, William Butterfield and Ted Phipps.
- [76] EE-WZM-5A96, *Acoustic Modeling*, Peter DeBonte.
- [77] EE-WZM-1B96, *Distributed Audio Controller*, Stephen S. Richardson.
- [78] EE-WZM-1A95, *Acoustic Hazard Meter*, Ronald D. Slack.
- [79] EE-WZM-2A95, *Forest Service DGPS*, Joshua J. Single and Michael T. Spadazzi.
- [80] EE-WZM-1C95, *Audio to MIDI Converter*, Jennifer R. Principe.
- [81] EE-WZM-1D95, *Low Cost Auralizer*, Jason R. Hills and Mark R. Paulson.
- [82] EE-WZM-3A95, *Passive Radiator Design*, Kevin R. Weldon.
- [83] EE-WZM-1C94, *Char Model Generation*, Colin J. Florendo.
- [84] EE-WZM-1D94, *Wide Area DGPS Simulator*, Daniel Cohen and Robert Schroter.
- [85] EE-WZM-2D94, *Digital Soundcard*, Timothy Alsberg (Russian Project Center).

- [86] EE-WZM-3D94, *Digital Univibe*, Andrew Willis and Daniel Toohey.
- [87] EE-WZM-1A94, *DSP Based Real-Time Audio Feedback Eliminator*, Kevin M. Eddy.
- [88] EE-WZM-2A94, *Digital LCD Oscilloscope*, William F. Brown and John F. Ebersole.
- [89] 93D236M, *MIDI Mapper*, Jonathan Kemble and Brian Candiloro.
- [90] EE-WZM-1C93, *Fault-Tolerant Computer*, Frederick N. Parmenter.
- [91] EE-WZM-1A93, *Wireless MIDI Controller*, Sanjay Raja, Charles Cimalore, Ty Panagoplos.
- [92] EE-WZM-2A93, *Multiple Pitch Detector*, Jeanne A. Sawtelle.
- [93] EE-WZM-3A93, *Multiprocessor Cache Coherence*, Lauren C. Lind and Norman E. Rhodes.
- [94] EE-WZM-1C92, *A Simulation of the DLX Architecture*, Lisa Harlow.
- [95] EE-WZM-2C92, *A New Microprocessor Development System*, Gregory B. Burlingame, David J. Fortin, Kevin S. Pearson.
- [96] EE-WZM-1A92, *Digital Audio Sampler*, Roger D. Gagnon and James M. Lach.
- [97] EE-WZM-2A92, *Intelligent Harmonizer*, Prabhjot S. Anand and Aftab M. Yusuf.
- [98] EE-WZM-3A92, *Computerized Audio Mixer*, Richard J. Wood.
- [99] EE-WZM-1B92, *Real-Time Harmonizer*, Mohiuddin M. Kahn.
- [100] EE-WZM-1A91, *Residue Number System Processor*, Ravdeep S. Anand and Christine A. Easton.
- [101] EE-WZM-2A91, *SCSI Bus Analyzer*, Brian Costello, George Delouriero, Matthew Maguire, and Keith Nevins.

4.3 Interactive Qualifying Projects (completed)

- [1] *Bell Towers*, Bowman, I.H., Casciola, I.O., Adiletta, M.J., Bruneau, C.D., WPI Venice Project Center, advised by W. Michalson and F. Carrera, 2019.
- [2] *Creating a Circular Economy with Urban Farming*, Ward, B.L., Cyran, B., Premo, J., Soens, N., WPI Venice Project Center, advised by W. Michalson and F. Carrera, 2019.
- [3] *Plastic-Free Venice*, S.L. Bonanno, V.C.Nguyen, A.H. Hagedorn, T.S. Howlett, WPI Venice Project Center, advised by W. Michalson and F. Carrera, 2019.
- [4] *30th Anniversary Exhibit*, N. Bajakian, J. Wong, J. DeDonato, and N. Stallings, WPI Venice Project Center, advised by W. Michalson and F. Carrera, 2019.
- [5] *Venice Crowdfunding*, T. Ferrara, F de Leo, M. Bernardo and S. O'Connell, WPI Venice Project Center, advised by W. Michalson and F. Carrera, 2019.
- [6] *Visitor Experiences in Venice*, T. King, C. Anderson, M. Laks, and C. Hoey, WPI Venice Project Center, advised by W. Michalson and F. Carrera, 2019.

- [7] *Venice From Above: Preserving Venetian Bell Towers*, Iuliano, C.T., Kavassalis, F.I., Colucci, N.D., Lessard, P., WPI Venice Project Center, advised by W. Michalson and F. Carrera, 2018.
- [8] *Celebrating 30 Years of the Venice Project Center*, Ellis, E.J., Morton, K.J., Carpinì, N.A.D., Hale, S.A., WPI Venice Project Center, advised by W. Michalson and F. Carrera, 2018.
- [9] *PreserVenice Launch: A Crowdfunding Solution to Preserving Venetian Heritage*, Hetherington, B.F., Berardi, D., Thompson, K.R., Joy, S.P., WPI Venice Project Center, advised by W. Michalson and F. Carrera, 2018.
- [10] *Tech Mecca in Giudecca*, McMahon, A.J., Hiscox, C.A., Maida, P.J., Lee, R.T., WPI Venice Project Center, advised by W. Michalson and F. Carrera, 2018.
- [11] *Exploring Urban Permaculture: Initializing a Path to a Greener Venice*, Jordan, A.S., O'Driscoll, K.J., Manca, R. A., WPI Venice Project Center, advised by W. Michalson and F. Carrera, 2018.
- [12] *Open For Business: Analyzing Venetian Storefronts*, Bartone, J.R., Scales, K.J., Racca, S.R., Chen, Y., WPI Venice Project Center, advised by W. Michalson and F. Carrera, 2018.
- [13] *Venice Without Obstacles*, DeRusha, A.C., Abenante, E.R., DiStefano, M.S., Jones, S.A., WPI Venice Project Center, advised by W. Michalson and F. Carrera, 2018.
- [14] *Documenting and Promoting the Impacts of the Melbourne Project Center*, Seely, C.A., Day, J.L., Cochran, I.L., and Carlson, K.A.M., WPI Melbourne Project Center, advised by S. McCauley and W. Michalson, 2017.
- [15] *Students' Mental Wellbeing in Universities Located in Melbourne*, Isaro, A., WPI Melbourne Project Center, advised by S. McCauley and W. Michalson, 2017.
- [16] *I See a Psychologist -- Reducing Stigma through Normalizing Mental Health Care in Australia*, Vayas, NN., Daci, E.G., and Bianco, C.E., WPI Melbourne Project Center, advised by S. McCauley and W. Michalson, 2017.
- [17] *Improving Web Presence and Stakeholder Interaction for the Emergency Services Foundation*, Savage, H.A, Sanchy, M.T., Capozzi, R. and Babel, B.M., WPI Melbourne Project Center, advised by S. McCauley and W. Michalson, 2017.
- [18] *Understanding Visitor Experiences at the Pauline Gandel Children's Gallery*, Nigro, J.T., France, G.T., Coppolino, J.R. and Blakslee, B.S., WPI Melbourne Project Center, advised by S. McCauley and W. Michalson, 2017.
- [19] *A Citizen Science Platform for Long-Term Monitoring of Microplastic Pollution in Port Phillip Bay*, Bayas, A.C., Buckley, M.J., Ford, C.K. and Lawes, J.A., WPI Melbourne Project Center, advised by S. McCauley and W. Michalson, 2017.
- [20] *A Comprehensive Methodology for Assessing the Quality of Solar Photovoltaic Systems*, Arthur, D.P., Hoey, C.J., Laffer, T. and Westgate, B., WPI Melbourne Project Center, advised by S. McCauley and W. Michalson, 2017.
- [21] *High Efficiency Power Inverter*, Grzegorz J. Klos and Robert Hall, 2015.

- [22] *An Analysis and comparison of affordable and ecological short-term transportation energy solutions*, Bryan Thomas Gleason, 2009.
- [23] *Lens and Lights Operational Overview*, Andrew Thomas Wilkins, ECE; Matthew Houstle, ECE; and Anthony R. Azersky, CS, 2009.

4.4 Graduate Theses Advised and Co-Advised

4.4.1 MS Theses (current)

- [1] Pratik Jawahar, “High-Level Exogenous Fault Detection in Multi Robot Systems with Variational Autoencoders and Normalizing Flows,” MS Thesis, co-advisor, 2022.
- [2] Rohan Walia, “Formation-Centric Software Interface,” MS Thesis, co-advisor, 2022.

4.4.2 MS Theses (completed)

- [1] Nathaniel Michaels, “A Modular Robotic AFO for detecting phase changes during Walking Gait,” MS Thesis, co-advisor, 2020.
- [2] Hernandez, A. C., “Implementing and Comparing Image Convolution Methods on an FPGA at the Register-Transfer Level,” MS Thesis, co-advisor, 2019.
- [3] Katie Gandomi, “Implementation of a Modular Software Architecture on a Real-Time Operating System for Generic Control over MRI Compatible Surgical Robots,” MS Thesis, co-advisor, 2018.
- [4] Adhavan Jayabalan, “Decentralized Persistent Connectivity Deployment in Robot Swarm,” MS Thesis, co-advisor, 2018.
- [5] Janani Mohan, “Dynamic Task Allocation in Robot Swarms with Limited Buffer and Energy Constraints,” MS Thesis, co-advisor, 2018.
- [6] Rogers, J.P., GNSS and Inertial Fused Navigation Filter Simulation, MS Thesis, co-advisor, 2018.
- [7] Christopher Bove, “Constrained Motion Planning System for MRI-Guided, Needle-Based, Robotic Interventions,” MS Thesis, co-advisor, 2018.
- [8] Vyas, Shivang, “Feature detection in an indoor environment using Hardware Accelerators for time-efficient Monocular SLAM,” MS Thesis, primary advisor, Worcester Polytechnic Institute, 2015.
- [9] Morin, Russell, “A Novel Localization System For Experimental Autonomous Underwater Vehicles,” MS Thesis, co-advisor, Worcester Polytechnic Institute, 2010.
- [10] Navalekar, Abhijit, “Design of an OFDM-Based VHF Modem,” MS Thesis, primary advisor, Worcester Polytechnic Institute.
- [11] Ahlehagh, Hasti, “Techniques for Communications and Geolocation Using Wireless Ad Hoc Networks,” MS Thesis, primary advisor, Worcester Polytechnic Institute, 2004.
- [12] Sebastian, Dalys, “Development of a Field-Deployable Ultrasound Scanner System,” MS Thesis, co-advisor, Worcester Polytechnic Institute, 2004.

- [13] Tobgay, Sonam, "Novel Concepts for RF Surface Coils with Integrated Receivers," MS Thesis, co-advisor, Worcester Polytechnic Institute, 2004.
- [14] Breen, Daniel, "Characterization of Multi-Carrier Locator Performance," MS Thesis, co-advisor, 2004.
- [15] Aghogho, Obi, "A Novel Radio Frequency Coil Design for Breast Cancer Screening in a Magnetic Resonance Imaging System," MS Thesis, co-advisor, Worcester Polytechnic Institute, 2003.
- [16] Fei, Ming, "Electromagnetic Detection, Infrared Visualization and Image Processing Techniques for Non-Metallic Inclusions in Molten Aluminum," MS Thesis, co-advisor, 2002.
- [17] Lavoie, Bruce, "Design and Implementation of an N-Channel Self Calibrating Audio System," MS Thesis, primary advisor, Worcester Polytechnic Institute, 2000.
- [18] Bogdonov, Gene, "Theoretical and Practical Implementation of Electrical Impedance Material Inspection of Powder Metallurgy Compacts," MS Thesis, co-advisor, Worcester Polytechnic Institute, 1999.
- [19] Messier, Andrew, "Modeling the Effects of Terrain Masking on GPS Accuracy and Integrity," MS Thesis, primary advisor, Worcester Polytechnic Institute, 1998.
- [20] Antonescu, Bogdan, "Elliptic Curve Cryptosystems on Embedded Microprocessors," Bogdan Antonescu, MS Thesis, co-advisor, Worcester Polytechnic Institute, 1998.
- [21] Lai, Qiang, "Ground-Penetrating Radar Data Processing System," MS Thesis, co-advisor, Worcester Polytechnic Institute, 1998.
- [22] Soria-Rodríguez, Pedro, "Multicast-Based Interactive-Group Object-Replication For Fault Tolerance," MS Thesis, co-advisor, Worcester Polytechnic Institute, 1998.
- [23] Hoy, William, "Audio Signal Denoising Using Wavelets," MS Thesis, primary advisor, Worcester Polytechnic Institute, 1997.
- [24] Proгри, Ilir, "Harmonic Flow Monitoring by means of Global Positioning System," MS Thesis, primary advisor, Worcester Polytechnic Institute, 1997.
- [25] Bretchko, Pavel, "Pulsed Hysteresis Graph System," MS Thesis, co-advisor, Worcester Polytechnic Institute, 1997.
- [26] Repkin, Dmitry V., "A Hierarchical Neural Network Based Data Processing System for Ground Penetrating Radar," MS Thesis, co-advisor, Worcester Polytechnic Institute, 1997.
- [27] Metsis, Sophocles, "Design of a Real-Time Capable, Fault-Tolerant, Distributed System," MS Thesis, primary advisor, Worcester Polytechnic Institute, 1996.
- [28] Hill, Jonathan, "Efficient Implementation of Mesh Generation and FDTD Simulation of Electromagnetic Fields," MS Thesis, primary advisor, Worcester Polytechnic Institute, 1996.
- [29] Dunkelberg, John, "FEM Mesh Mapping to a SIMD Machine Using Genetic Algorithms," MS Thesis, co-advisor, Worcester Polytechnic Institute, 1996.

- [30] Leuenberger, Georg, "Design and Development of a Microprocessor Based Gauss Meter," MS Thesis, co-advisor, Worcester Polytechnic Institute, 1995.
- [31] Valentino, Ralph, "DISC: A Dynamic Instruction Set Coprocessor," MS Thesis, primary advisor, Worcester Polytechnic Institute, 1995.
- [32] Muley, Aalok, "A Fault Tolerant Network for a Real-Time Environment," MS Thesis, primary advisor, Worcester Polytechnic Institute, 1994.
- [33] Mohan, Surrender, "Automatic Surface Mesh Generation for 3D Solid Models Using Delaunay Algorithm," MS Thesis, co-advisor, Worcester Polytechnic Institute, 1994.
- [34] Petrangelo, John, "Experimental Preconditioners for Large Dense Systems," MS Thesis, co-advisor, Worcester Polytechnic Institute, 1994.
- [35] Schneider, Eric, "Design, Simulation, and Analysis of a 3D Integrated Optical Computer," MS Thesis, primary advisor, Worcester Polytechnic Institute, 1993.
- [36] Palmer, Bradley, "A Comparison of Three Protocols Supporting Time-Dependent and Time-Independent Communications," MS Thesis, primary advisor, Worcester Polytechnic Institute, 1992.
- [37] Clayton, Shawn, "An Analysis of the Real-Time Behavior of Galactica Net," MS Thesis, primary advisor, Worcester Polytechnic Institute, 1992.
- [38] Levergood, Thomas, "An Experimental Evaluation of Split User/Supervisor Cache Memories," MS Thesis, primary advisor, Worcester Polytechnic Institute, 1992.
- [39] Lavalee, James, "The Design and Development of Real-Time Systems Using Ada and the Activation Framework," MS Thesis, co-advisor, Worcester Polytechnic Institute, 1992.
- [40] Velazques, Javier, "The Development of a Real-Time Environment Using the Activation Framework," MS Thesis, co-advisor, Worcester Polytechnic Institute, 1992.

4.4.3 Ph. D. Dissertations (current)

- [1] Vincenzo Diluoffo, "Security in the Robot Operating System Version 2 (ROS 2) Environment," primary advisor.
- [2] Jitesh, "Ad-Hoc Networking for Bandwidth Limited LMR Systems," primary advisor.

4.4.4 Ph. D. Dissertations (completed)

- [1] Carvalho, P. A., "Advancing Technologies for Interventional MRI Robotics with Clinical Applications," 2019.
- [2] Ferreira, PVR "SRML: Space Radio Machine Learning," Ph.D. Dissertation, co-advisor, Worcester Polytechnic Institute, 2017.
- [3] Iyer, Vishwanath, "Broadband Impedance Matching of Antenna Radiators," Ph.D. Dissertation, co-advisor, Worcester Polytechnic Institute, 2010.
- [4] Navalekar, Abhijit, "Distributed Digital Radios For Land Mobile Radio Applications," Ph.D. Dissertation, primary advisor, Worcester Polytechnic Institute, 2009.

- [5] Parikh, Hemish, "Design of an OFDM Transmitter and Receiver for Precision Personnel Location," primary advisor.
- [6] Proгри, Ilir, "An Assessment of Indoor Geolocation Systems," Ph.D. Dissertation, primary advisor, Worcester Polytechnic Institute, 2003.
- [7] Li, Xinrong, "Super-Resolution TOA Estimation with Diversity Techniques for Indoor Applications," Ph.D. Dissertation, co-advisor, Worcester Polytechnic Institute, 2003.
- [8] Leuenberger, Gerog H. W., "Electrostatic Density Measurements in Green-State PM Parts," Ph.D. Dissertation, co-advisor, Worcester Polytechnic Institute, 2003.
- [9] Bogdanov, Gene, "Radio-Frequency Coil Design for High Field Magnetic Resonance Imaging," Ph.D. Dissertation, co-advisor, Worcester Polytechnic Institute, 2002.
- [10] Elbirt, Adam J., "Reconfigurable Computing for Symmetric-Key Algorithms," Ph.D. Dissertation, co-advisor, Worcester Polytechnic Institute, 2002.
- [11] Bretchko, Pavel, "Design and Development of Ultra-wideband DC-Coupled Amplifier," Ph.D. Dissertation, co-advisor, Worcester Polytechnic Institute, 2001.
- [12] Hill, Jonathan, "Development of an Experimental Global Positioning System (GPS) Receiver Platform for Navigation Algorithm Evaluation," Ph.D. Dissertation, primary advisor, 2001.
- [13] Spasojević, Mirko, "Creation of Sparse Boundary Element Matricies for 2-D and Axi-symmetric Electrostatic Problems Using a Bi-orthogonal Wavelet," Ph.D. Dissertation, co-advisor, Worcester Polytechnic Institute, 1997.
- [14] Shi, Funan, "Optimal Designs of Gradient and RF Coils for Magnetic Resonance Imaging (MRI) Instrument," Ph.D. Dissertation, co-advisor, Worcester Polytechnic Institute, 1996.

5. Proposals and Funding:

5.1 Funding Received

\$300,000	MRI: Development of an autonomous, Connected and Data-Driven Vehicle for Multi-Disciplinary Research, Co-PI, 09/13/16.
\$200,000	Advanced Bayesian Methods for Autonomous Navigation, Co-PI, 07/25/11.
\$50,524	PCOG Broadband Modem, PI, \$50,524, 05/15/09.
\$839,000	Real-Time Troop Physiological Status Monitoring System, Co-PI, 09/06/07.
\$83,726	State Communications Interoperability, PI, 07/18/07.
\$224,822	MANET Protocols for Capacity-Limited Channels, PI, 03/08/07.
\$44,366	TATRC: Wireless Sensor Communications, Co-PI, 12/20/06.
\$95,000	Real-Time Troop Physiological Status Monitoring System, Co-PI, 02/13/06.
\$3,225,000	Real-Time Troop Physiological Status Monitoring System, Co-PI, 12/19/05.
\$1,973,286	Precision Indoor/Outdoor Personnel Locator, Co-PI, 09/23/05.

\$25,000	Sensor-on-a-Chip for Electrophysiological Monitoring, Co-PI, 08/08/05.
\$1,245,000	Real-Time Troop Physiological Status Monitoring System, Co-PI, 12/23/04.
\$1,370	WPI-NanoSAT Program, Co-PI, 11/03/04.
\$37,408	Precision Indoor/Outdoor Personnel Locator, Co-PI, 10/05/04.
\$74,048	Real-Time Troop Physiological Status Monitoring System, PI, 09/15/04.
\$813,141	Real-Time Troop Physiological Status Monitoring System, PI, 12/08/03.
\$255,496	Precision Indoor/Outdoor Personnel Locator, Co-PI, 10/31/03.
\$3,246	WPI-NanoSAT Program, Co-PI, 10/20/03.
\$2,789	WPI-NanoSAT Program, Co-PI, 03/06/03.
\$827,000	Real-Time Troop Physiological Status Monitoring System, PI, 11/22/02.
\$14,866	Norfolk County Sheriff's Office Data Mining, Co-PI, 02/01/02.
\$54,483	Auto-calibrating surround sound system, PI, 2001.
\$11,252	Auto-calibrating surround sound system, PI, 2000.
\$18,977	GPS-Based Attitude Determination System, PI, 07/1998.
\$70,000	Development of an Electric Resistivity Instrument for the Testing of Green-State P/M Compacts, Co-PI, 01/1997.
\$10,550	GPS Hazard Detection, Co-PI, 1996.
\$200,000	Integrity for the Global Positioning System - Supplemental Funding I, Co-PI, 1995.
\$3,000	GPS-Based Tracking of Forest Vehicles, PI, 1995.
\$7,200	Acoustic Identification of Mosquito Species, Co-PI, 1995.
\$9,978	Acoustic Identification of Mosquito Species, Co-PI, 1995.
\$11,527	Laboratory Equipment for Microkernel Based Embedded Systems, Co-PI, 1995.
\$74,388	RF Circuit and Antenna Modeling on High Performance Computers, Co- PI, 1994.
\$199,075	Integrity for the Global Positioning system, PI, 1994.
\$326,336	3D Modeling of Microwave Antennas on High-Performance Parallel Computers, Co-PI, 1993.
\$338, 687	Integrity for the Global Positioning system, Co-PI, 1993.

6. Honors, Awards, and Recognitions:

Elected Senior Member of the IEEE.

Joseph Samuel Satin Distinguished Fellowship awarded for the 1994-1995 academic year.

Aldo Miccioli Fellowship recipient from Raytheon Equipment Division.

ION Best Paper Award - GPS-96 for W. R. Michalson, W. Cidela, et. al., "A GPS-Based Hazard Detection and Warning System," in review, " *ION GPS-96, 9th International Meeting of the Satellite Division of the Institute of Navigation*, pp. 167-175, Kansas City, MO, Sep 17-20, 1996

2nd Place - 2004 ECE Department MQP Award / Provost's MQP Award for *GPS-Based Orbit and Attitude Determination System for PANSAT*, Joshua Holwell, Andrew Coonradt and Himanshu Agrawal.

1st Place - 2003 ECE Department MQP Award / Provost's MQP Award for *Personal Inertial Navigation System*, Jason DeChiaro and Chris Struus.

1st Place - 2002 ECE Department MQP Award / Provost's MQP Award for *Handspring Digital Voltmeter*, Andrew Young and Pavel Loven.

3rd Place - 1998 ECE Department MQP Award / Provost's MQP Award for *Design of a Personal Handheld GPS Receiver*, Jeffery Alderson and Helder Machado.

2nd Place - 1997 ECE Department MQP Award / Provost's MQP Award for *Distributed Audio Controller*, EE-WZM-1B96, Stephen S. Richardson.

3rd Place - 1997 ECE Department MQP Award / Provost's MQP Award for *GPS Hazard Detector II*, EE-WZM-2A96, Will Brothers, Jon Day, and John Zaghi.

1st Place - 1996 ECE Department MQP Award / Provost's MQP Award for *GPS Hazard Detector*, EE-WHE-9601, Michael Roberts, William Cidela, and Chris Mangiarelli.

6.1 Memberships and offices held in professional society

- Institute of Electrical and Electronic Engineers, Senior Member
- Institute of Navigation
- Royal Institute of Navigation
- American Society of Engineering Educators
- National Academy of Inventors
- Society of Automotive Engineers

6.2 Professional Service

Massachusetts Board of Bar Overseers Hearing Committee Member, 2010-Present.

Steering Committee – 2009 First Annual Robotics Innovations Competition and Conference (RICC '09), Nov 7-8, Worcester, MA, 2009.

Conference Technical Co-Chair – 2009 IEEE International Conference on Technologies of Practical Robot Applications (TePRA 2009), Nov. 9-11, Woburn, MA, 2009.

Reviewer – Proposal number CRDPJ 379622-08, Natural Sciences and Engineering Research Council of Canada (NSERC), Mar. 2009

Co-Chair – Urban and Indoor Geolocation, Institute of Navigation International Technical Meeting (ITM2009), Anaheim CA, Jan. 2009.

Reviewer – Proposal number CRDPJ 379622-08, Natural Sciences and Engineering Research Council of Canada (NSERC), Mar. 2009